The FOUNDRY

Volume 52
Number 1

Published
Semimonthly

CLEVELAND, OHIO, JANUARY 1, 1924

Industry on the African Rand

Industrial Activities Pertaining to the Engineering and Foundry Business with Sidelights on Geographical Features and on the Social Problems of the Territory Are Outlined

BY GEORGE W. CARSON

CAPE TOWN in its beautiful situation at the head of Table bay, 30 miles from the Cape of Good Hope and lying in the shadow of Table mountain, appeared doubly beautiful and alluring on Aug. 1, 1921, when our vessel dropped anchor inside the breakwater after a 24-day voyage from London. The cape presents an impressive spectacle on the way in and a magnificent panorama is spread before the eyes of a spectator on a vessel in the bay. After a long sea voyage the landsman welcomes the feel of solid earth under his feet even if it does at first rise up and meet him in a disconcerting manner. On shipboard a person instinctively acquires more or less of a rolling gait to compensate for the motion of the heaving decks, especially if the water is rough. On this particular voyage we had a comparatively fair passage with the exception of a few wild days south of the equator. Nothing extraordinary, but still it was plenty. After clearing our baggage at the customs we spent some time sight seeing in this historical old Dutch town once known as Kapstad. At present the population is given as 125,000 and the city is the principal commercial and distributing point for the entire Cape colony.

The business section of the city is confined to approximately four squares containing one or two good hotels and a great number of saloons, or bars as they are known in this part of the world. South Africa is a great grape country and the fermented product is offered for sale freely and at a remarkably low figure. For example, a first class bottle of wine may be had for 4 or 5 shillings ($1.00 to $1.25) and brandy equal to the best imported French sells for 8 shillings ($2.00). Hotel rates average 9 or 10 shillings per day ($2.25 to $2.50) and although the hotels are run on the European instead of the one time familiar American plan, still in local parlance, they put you up very well. There is none of the hurry and bustle one associates with hotels in the United States and Canada.

The Rand district in the Transvaal to which we were bound is only about 300 miles from Delagoa bay on the east coast of Africa, but excellent railroad facilities are provided between Cape Town and Johannesburg and we traveled by that route. African railroad equipment apparently is a cross between English and American. The coaches are built on the compartment plan with a corridor extending all along one side. A dining car and a bar are attached to the train where meals and other refreshments are served at stated periods. The drinks cost but little and the meals are

The Foundry Slant

George W. Carson, a foundryman of extended experience in the iron and steel foundries of the United States was engaged in Detroit in the early part of 1921 to accept an important position in a foundry located on the great gold reef in the Transvaal, South Africa. He comments in an informal and interesting manner on many features of a foreign country as viewed through American eyes. He touches on historical and economic phases of the subject and throws in some interesting side lights on transportation and natural resources of the country. Intimate detail of foundry practice as compared with American practice will be appreciated on this side of the Atlantic.

served at a flat price ranging from $1.00 to $1.50. The diner may content himself with one dish or he may include the entire list on the menu card. The compartments are converted into sleeping rooms by pulling out the backs of the seats and slinging them midway between the seat and the top shelf. Four beds may be set up in each compartment in this manner and at a pinch six persons may be accommodated by placing all the light baggage on the floor. *Skoff time*, the South African term for eating, is announced by the waiter to each compartment in turn.

The 48-hour ride over the 1000 miles intervening between Cape Town and Johannesburg is entirely without variety afforded by scenery incident to practically every other country in the world. Neither lake, river, wood or mountain breaks the monotony of the plain, bare *veldt* extending to the horizon on all sides. Occasional small isolated hills known as *kopjes* only serve to accentuate the general air of loneliness and evoke a feeling of sympathy for the early Boer emigrants who slowly and painfully drove their teams of oxen over this trackless wilderness 100 years ago.

The railroad is built to a narrow gage of 3 feet 6 inches and the rocking side to side motion incident to this narrow support is quite evident when the train is traveling fast. Boulders and small stones scattered over the surface of the *veldt* are burned black by the equatorial sun and the fact that the natives are the same color probably may be traced to the same cause.

Although the land apparently is flat, still there is a gradual upward trend to where Johannesburg, the largest city in the Transvaal, is situated some 6000 feet above sea level. It is a comparatively young city and in many respects offers interesting contrast to staid, conservative old Cape Town. At present the population is approximately 200,000 and the name of the city has been localized to Joburg, probably from the same motive that has converted two prominent American cities to St. Joe and Frisco.

Few cities can parallel the growth of this magic community that dates its birth to 1886 when the great gold reef was thrown open to exploitation by the then Dutch government of the South African Republic. The city takes its name from Johannes, a Dutch farmer, and the few tin shanties of the first prospectors have developed into the greatest commercial metropolis in South Africa. It is located approximately in the center of the great gold reef which extends east and west for 40 miles, from Randfontein on the west Rand to Springs on the east. The comparatively narrow area of the reef is covered with a continuous line of smoke stacks and hoisting machinery, while the earth is in a constant tremor under roaring batteries of stamp mills. Great hills of crushed silica sand represent the residuum, the final waste material that is discarded after the final washing that removes the last vestige of the precious metal. The gold is mined in the form of quartz and is crushed to powder in the mills as a preliminary to the recovery of the gold.

Mining machinery and equipment has been imported from all the principal machinery building countries in the world and a casual glance at many of the name plates will disclose that the United States played a prominent part in supplying this material. The fact that American mining engineers dominated the early activities in the territory is reflected in many ways including two stations along the railroad line known as Denver and Cleveland, respectively.

Racial and national characteristics, animosities, personal and public ambitions served to keep the territory in the limelight of publicity for almost 20 years. Smoldering resentment on the part of the Boers for the *Utlanders* was fanned into an open flame by the Jameson raid of 1896 and although the flame was extinguished after a manner, the embers remained and finally burst forth in a conflagration in 1899 that involved the services of nearly half a million British soldiers over a period of three years. That it finally was extinguished thoroughly is evident from the fact that peace has reigned in the Transvaal for over 20 years. Possibly with the exception of John Hays Hammond, one of the most widely known mining engineers in the world, now resident in the United States, all the prominent men involved in the Boer war are no more. Paul Kruger died in Switzerland, Kitchener is at the bottom of the North sea in the wreck of the torpedoed HAMPSHIRE and the remains of Cecil John Rhodes long since have moldered to silent dust under the immense granite boulder erected to his memory in the land to which he devoted the greater part of an exceedingly colorful life.

FIG. 1—CORLISS ENGINE CYLINDER WEIGHING 15,000 POUNDS MADE BY THE EAST RAND ENGINEERING WORKS—THE MOLD WAS MADE HORIZONTALLY FROM A SPLIT PATTERN

Pretoria, 40 miles northeast offers contrast in many respects to Johannesburg. It is a decidedly Dutch city of 130,000 people and is the capital city of the Union of South Africa. It resembles many American cities in that the streets are symmetrical and run either north and south or east and west. To a great extent they are ornamented on both sides by shade trees. The impressive group of government buildings graces a hill overlooking the city.

On the way out to the iron range situated on the western town lands of Pretoria we passed through Kesk street and saw the cottage at one time occupied by Paul Kruger and his wife. We are reminded that the lady died here a few

months before hostilities ceased and while her husband was a fugitive in Europe. The cottage is of plain cement construction and in keeping with the reputed taste of the owner.

The iron ore deposits in the vicinity of Pretoria cover a vast area. The surface is exposed to such an extent that one can hear the clink of the metal when a shod horse passes over it. One blast furnace with a daily capacity of 200 tons has been placed in operation and furnishes a considerable quantity of the iron used in the territory. We had no opportunity of checking up on the analysis of the iron in the yard. A superficial examination would seem to indicate that some of the pigs are quite hard while the fracture on others resembled that of a good grade of foundry iron. We were given to understand that iron can be produced under favorable conditions due to the low cost of labor and materials. The only feature that detracts from the general situation is the

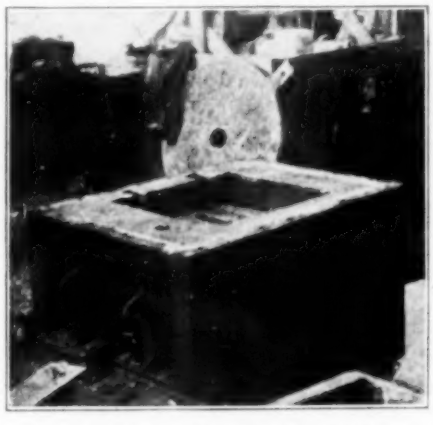


FIG. 2—DRAG MOLD FOR WATER COOLED ANVIL BLOCK

necessity of employing high sulphur coke with a resulting high sulphur content in the iron. However, it is anticipated that this trouble eventually will be ironed out.

With possibly few exceptions, foundrymen in America have little or no conception of the extent to which the foundry and allied industries have been developed in the Witwatersrand (Whitewatersand) district. According to the latest statistical reports, 250 establishments are devoted to the working of metals. They are grouped as follows: Engineers, founders, blacksmiths 180; plumbing, roofing and galvanizing, 50; copper and cutlery, 6 and wire working, 6. Approximately 20 metal working plants are not classified.

The total value of land and buildings is set down as $2,500,000; an additional valuation of $5,000,000 is given for tools and equipment. Europeans are employed to the number of 5795 and the number of natives is listed at 9000. Wages for the year ending June, 1921 amounted to $11,500,000; the average white man earned $1670 during the year. The average wage tarned by a native in the same time totaled $201.

These figures are given in pounds sterling in the report, but for the benefit of American readers I have taken the liberty of translating them into dollars at a normal rate of exchange.

Raw material was used to the value of $12,700,000, of which $325,000 is credited to materials produced in South Africa. The total value of the finished product is set down as $27,500,000.

The foundry and general engineering industry is listed second in importance to mining. At least 30 fairly large engineering firms are operated in the Witwatersrand district. Foundries are attached to 16 of these plants and in addition numerous small shops are scattered all over the reef. Some of these are run by one man and in others two or three molders run them in partnership. Approximately 800 tons of castings are produced monthly. Johannesburg operates one foundry after the manner of the city of Chicago where all castings are made for the municipality. The total number of molders and coremakers is between 250 and 275 organized as the South African Molders society. White supremacy is, if possible, more of a fetish in South Africa than it is in Australia and New Zealand. The color bar is absolutely rigid and only white men are permitted to work at skilled occupations.

Sweeps Extensively Employed

Practically all the castings in iron, brass and steel made in the district may be grouped under the heading of maintenance and repair of mining machinery. On account of the scarcity of wood for every purpose including the construction of patterns, the spindle and sweep method of making a mold is resorted to extensively both in green and dry sand. Skeleton patterns also are employed, particularly for pipe castings, to a greater extent than is usual in American foundries. From the foregoing it is apparent that a high degree of manual skill coupled with ingenuity and initiative are required on the part of the molders employed in these foundries.

Molds for gray iron castings are made in a local sand red in color and of the following analysis: Silica 81.40 per cent; moisture 5.20 per cent; oxide of iron (ferric) 8.60 per cent; alumina 4.00 per cent and magnesia 0.80 per cent. This sand covers practically the entire surface of the Orange Free State and the Transvaal. As a practical molder and basing my opinion on an extended experience with many varieties of molding sand, I should say that this sand is at best only mediocre for molding use.

Considerable time and labor have been expended in an effort to render the sand workable, but in my opinion the effort has not been directed along the proper lines. The sand has several desirable features and only requires proper manipulation to render it particularly adaptable for green sand molds. The high alumina content interferes with the desirable properties usually conferred on sand that has been treated in a pan mill. The rollers simply flatten the sand into a hard cake on the bottom of the pan. In my opinion a more satisfactory method of treating the sand would be to slime it, then add a sufficient quantity of sharp sand and allow the mass to weather in the open. Eventually, progress will be made along the line of sand preparation to a point where ap-

FIG. 3—DRUM CASTING WAS POURED IN THE PIT IN WHICH IT WAS SWEPT IN LOAM. THE IRON WAS MELTED IN AN ELECTRIC FURNACE

proximately 70 per cent of the castings may be made in green sand molds. At present nearly all molds are made in dried or skin dried molds. There is a familiar foundry saying to the effect that the oven is a good molder, but the sight of a Rand foundry with so many fires burning on top of jobs bedded in the floor does not appeal to American eyes and suggests high operating cost and loss of time.

In addition to the red sand, several varieties of superior grades of molding sands are available. Decayed reef, or to use the more familiar term, rotten rock is deposited in many places. Yellow loam similar to that employed in several sections of the United States is quite plentiful and usually found on top of valuable seams of fire clay. The geological formation of this remarkable country presents many interesting features to any person connected with the

foundry or any other business involving the use of sand.

A view of the huge piles of silica sand in the vicinity of the ore reduction plants reminds a person of the labor and machinery involved in preparing silica sand for use in the steel foundries of America. One also is led to regret that these vast piles of ready-to-use sand are so far away. As a matter of interest and for general comparison I have forwarded samples of the various sands found in this district to the sand research committee of the American Foundrymen's association.

Only three foundries in South Africa are engaged in the production of steel castings. A railroad shop in Pretoria is equipped with a side blow converter. The second shop melts steel in a 3-ton electric furnace. The third foundry operates an electric furnace with a capacity of 6 to 7 tons to a heat. Hematite iron has to be imported from Great Britain for use in the converter and as a result the production cost of steel castings made by this method are high. The large steel furnace was erected primarily for the production of steel for rolling purposes in a merchant mill. Up to the present it has not justified its original cost and upkeep. Even an abundance of steel scrap cannot offset a price of $100 a ton for finished shapes, while castings are quoted at $300 to $400 a ton. Average gray iron castings are charged for at the rate of $105 to $120 a ton.

White Iron Castings

Reference has been made to the prevalence of the spindle and sweep and also the skeleton pattern. A considerable quantity of the castings are repetition work, and even though wood is scarce and expensive I am inclined to the opinion that complete patterns in many cases would prove an economy in the long run. Habit and custom are difficult features to change.

In some respects the foundry practice resembles that prevailing in America For example one firm on the east side of the reef operates a machine made by a Cleveland manufacturer. A second company has a gravity type machine and also a bumper that were made in the United States. Each of these machines makes a creditable showing on repetition castings in white iron. Owing to the present high cost of hard steel castings, white iron castings are employed extensively for the wearing parts of reduction machinery. The accompanying illustrations indicate to some extent the character of some of the heavier castings made in the district. The heaviest casting ever made on the Rand weighed about 14 tons. The general run of castings range from 1 pound or less up to 5000 pounds.

The hammer block shown in Fig. 4 was made from 0.35 per cent carbon steel, after similar castings made of gray iron, white iron and semisteel had failed in service. In foundry terms the casting is a plain *chunk* weighing about 2 tons. However, the fact that it is provided with a water chamber lends it a certain amount of interest from a foundryman's viewpoint.

Running Water Applied

The water chamber was formed from a length of 1⅛ inches extra heavy steel pipe bent in the general shape of the letter *W*. The two ends of the pipe projected through one side of the mold and also through suitable holes in the side of the flask to provide for a hose connection with the water supply. A stream of water at 42 pounds pressure was kept flowing through the pipe during the casting operation. The pipe was supported on heavy chaplets top and bottom to resist the intense heat from the body of steel 36 inches square, 18 inches deep. Originality is not claimed for this method. I first became familiar with it while making water cooled furnace doors in Pittsburgh. The metal was melted in an electric furnace and poured through a gate in the bottom of the mold.

FIG. 4—TWO-TON ANVIL BLOCK CASTING SHOWING WATER COOLING CONNECTIONS

The 14-groove drum shown in Fig. 3 was swept in a loam mold without the assistance of a flask, a cupola or a stove for drying the core. The outside wall and the bottom were swept up, finished and dried in the pit. The core was made and dried in a second pit and the cover was swept on a plate provided with dabbers. The iron was melted in the electric furnace.

In Fig. 1 is shown a corliss engine cylinder weighing 15,000 pounds made by a long established company on the east Reef. It finished up perfectly in every particular and reflects a great deal of credit on the ingenuity and skill of the men responsible for its production.

Steel rolls ranging in weight from 1000 to 10,000 pounds are all made in local foundries. Formerly they were imported at an almost prohibitive cost. The molds are swept in halves horizontally and then turned up on end before they are filled with metal.

In mechanical skill and the ability to meet emergencies the foundrymen of this country are as competent as their contemporaries in the United States, but in all probability it will be many a long day before they have an opportunity of duplicating the feat of the Snow Steam Pump Works, Buffalo, in casting twenty 116-ton engine frames for the Illinois Steel Co., several larger bed plates made by the Mesta Machine Co., Pittsburgh, or many of a somewhat similar character made by the Allis-Chalmers Co., West Allis, Wis. In passing I also might say that it will be many a long day before foundrymen in this or any other country equal the record hung by James A. Murphy at the plant of the Owen-Hooven-Rentschler Co., Hamilton, O., when during the war period he turned out a complete set of castings for a triple expansion 2500-horsepower marine engine every working day for over a year.

Local Conditions

All unskilled labor is recruited from the colored native tribes, Zulu, Basuto, Shangani, Swazi and Makosha. Usually they are of a somewhat shiftless character after the manner of their distant cousins in the southern United States. However, as is the case with these same cousins, many of the men after training for a year or two develop into competent workmen. They are not permitted to work at any of the skilled trades, but serve as helpers in the workshops and mines. The great majority are employed under ground assisting the white miner in his task of blasting and quarrying his way through a vein of gold bearing quartz into the bowels of the earth. Some of the working levels have descended to a depth of 6000 feet. The quartz varies in its gold content from a few pennyweights up to 10 ounces to the ton. An average for the entire Reef is in the vicinity of 10 pennyweights.

Phthisis, a form of tuberculosis, is one of the most detrimental factors in connection with the gold mining industry in the Rand. It has claimed victims by the thousand and although a great deal has been done in recent years in the way of preventive measures, it still claims a heavy toll each year.

Industry of all kinds had a serious set back in 1922. The chamber of mines, a governing body which dictates the policy of the gold industry, insisted on a reduction of production costs and this action led to a long and disastrous strike on the part of the workmen. A 12-week cessation of work culminated in a violent revolt which was only quelled after the government had placed in actual service

thousands of troops and resorted to big guns and airplanes to establish law and order. The whole incident is regrettable in that it retarded the progress of the country, cost so many lives and accomplished nothing so far as its original intention was concerned. The industrial status of the worker is the same today as it was before. The natives are paid from 50 to 60 cents a day and the mechanics are paid from $30 to $40 a week.

In general it may be stated that taking all the factors into consideration, there is not much to choose between the foundry business in South Africa and America. Gray iron foundries probably are adequate in number and capacity, but in my opinion a wide field exists for the further development of the steel casting business. Millions of tons of iron ore in sight would seem to promise development along the line of pig iron production after the problem of securing suitable coke has been solved.

Tin Slightly Detrimental to Cast Iron

BY C. E. WILLIAMS, C. E. SIMS and C. A. NEWHALL

TESTS were made in which iron, coated with both tin and lead, commonly called terne plate, and galvanized scrap were melted with carbon. In the melt using scrap containing 1.9 per cent tin and 2.5 per cent lead, practically no elimination of the tin and complete elimination of the lead were obtained. Some of the lead was vaporized and the rest of it, on tapping ran out of the furnace ahead of the molten iron in which it was insoluble. In the test using galvanized scrap containing 8.22 per cent zinc, the resultant metal contained only 0.20 per cent zinc. Thus, unlike tin, lead and zinc are both readily removed from iron by melting in the electric furnace.

To determine the degree of detinning possible in the cupola, the following experiments were conducted. Charges consisting of 25 pounds of tin plate scrap, 75 pounds of gray iron and a large excess of coke were melted in a small cupola 18 inches in diameter. In one case, when a strong blast was used, the resultant metal contained only half of the tin charged. In another instance, in which a light blast was used, the temperature of the metal was consequently low and a viscous melt was obtained with practically no elimination of tin. A sample obtained from the castings made at a local sash weight foundry by melting four parts gray iron and one part baled tin plate scrap in large cupola was analyzed and found to contain 0.37 per cent tin. Assuming that the tin plate scrap contained 1.7 per cent tin, the average for all scrap detinned in 1921, a recovery of practically 100 per cent of the tin was obtained.

One thousand pounds of synthetic cast iron was made in the electric furnace from tin plate scrap and used as the iron in a regular cupola melt at a local foundry. The iron before melting in the cupola contained 1.25 per cent tin, and after melting 1.23 per cent tin, thus showing practically no elimination.

It is apparent, therefore, that some elimination of tin, probably up to 50 per cent, may be effected by melting thin sheets in a strongly oxidizing atmosphere, that there is practically no loss of tin when melting large pieces of iron containing tin in solid solution, and that the tin romoved in cupola melting is dependent upon the conditions of melting and state in which the tin is present.

Believing it to be impractical to effect detinning in the electric furnace or the cupola, experiments were then conducted to determine what effect tin had on cast iron, and whether suitable castings could be made from synthetic cast iron made from tin plate scrap. Test bars containing quantities of tin varying from 0.05 to 5.0 per cent were cast from pig iron melted with the required proportions of tin in an electric furnace. The tests on these bars showed that tin increases the hardness and decreases the transverse, compressive and tensile strengths, as well as the resistance to impact.

Chemical analyses showed a decrease in graphitic carbon as the tin content increased, and microscopic examination gave evidence that less than 1 per cent of tin has no effect upon the size and shape of the graphite. These effects of tin are in direct proportion to the amount present, and roughly 1 per cent of tin will reduce the strength of gray iron 15 per cent. The effect on hardness and graphitic carbon will not be over 10 per cent. When the tin content is 2 per cent or more, the molten iron appears dirty, does not fill the mold well, and the resulting castings are found to be rough and porous.

It seems, therefore, that tin plate scrap or old tin cans can be used in the production of synthetic gray iron for the ordinary grade of castings provided the tin content of the product can be kept to 1 per cent or less. If the scrap contains more than 1 per cent of tin it should be mixed with enough scrap free from tin to bring the average tin content to about this figure.

To obtain more data on the value of tin plate scrap as a raw material in the manufacture of synthetic cast iron, one thousand pounds of it were melted and carburized in a basic lined, electric arc furnace. The composition of the product is shown as follows:

	Before Melting, per cent	After Melting per cent
Carbon	3.85	3.78
Silicon	1.34	1.13
Manganese	0.83	0.60
Phosphorus	0.45	0.56
Sulphur	trace	trace
Tin	1.25	1.23

The metal was taken to a local foundry and used in one of the regular cupola melts. Both heavy sections and tin ornamental castings were made from it. All parts of the molds were well filled, and the castings without exception were smooth and sound. A machining test was made by the manager, who was well satisfied with the iron and gave the following report:

Depth of chill, nil. Very soft. Cuts readily with hack saw. Drills easily with ordinary carbon drill. Turns readily in lathe at considerably over ordinary speed. On facing cut run at 120 feet per minute, $\frac{1}{16}$-inch depth of cut, $\frac{1}{32}$-inch feed with high speed steel. No difficulty to make deep cut with parting tool. Fracture very fine, dense, close grain, rather dark in color. Elasticity good.

Five hundred more pounds of synthetic iron of the same composition was made and submitted to another foundry for a similar test; another favorable report was returned.

From a paper presented at the New York meeting of the American Electrochemical society. Of the three authors, C. E. Williams and C. E. Sims are metallurgist and electrometallurgist, respectively, Northwest Experiment station, United States bureau of mines, Seattle, and C. A. Newhall is connected with the Washington Electrochemical Co., Seattle.

The Link Belt Co., Chicago, has issued a calendar for the ensuing year. This consists of 12 pages 16 x 24 inches in size. On them are portrayed by Jeffrey Grand, a Chicago artist, the construction features of various types of equipment made by the company.

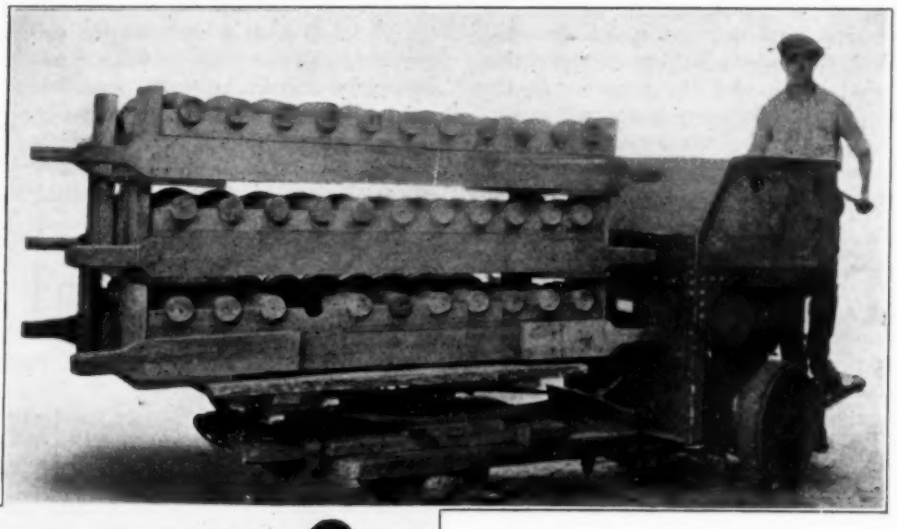


FIG. 1—AT RIGHT—AN ELECTRIC TRUCK PERFORMS THE SAME DUTY AS THE GASOLINE TRUCK IN THE CORE ROOM

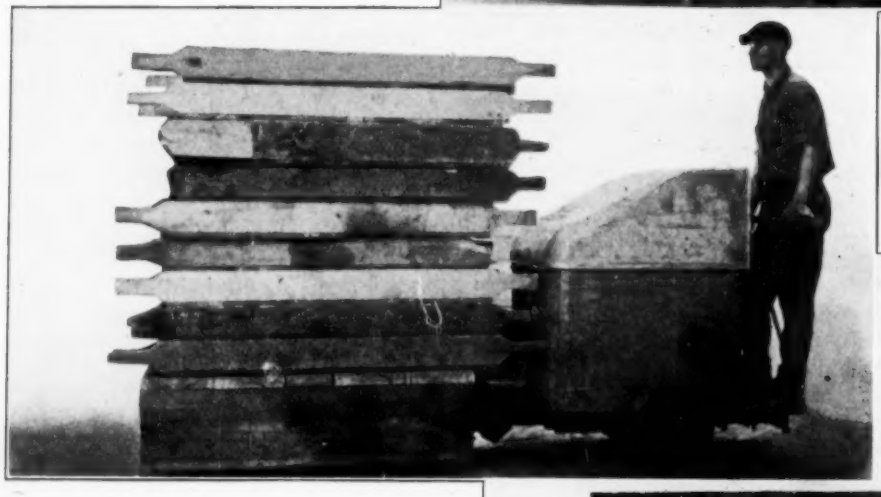


FIG. 4—BELOW—GASOLINE POWERED TRUCKS ARE EQUIPPED WITH SPRING PLATFORMS TO CARRY THE MORE DELICATE CORES

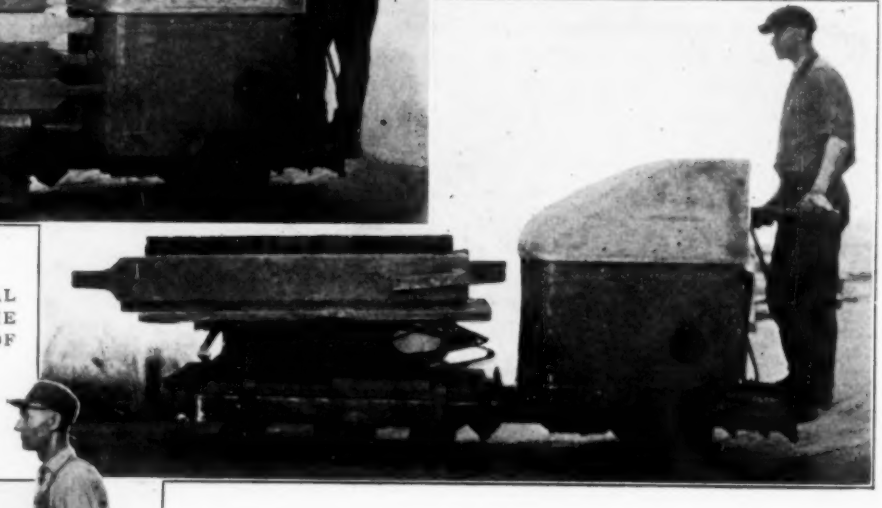


FIG. 2—ABOVE—THE MORE SUBSTANTIAL CORES ARE CARRIED WITHOUT THE USE OF SPRING SKIDS; A NUMBER OF RACKS ON A TRUCK

FIG. 5—BELOW—IT HAS BEEN FOUND ADVANTAGEOUS TO CARRY SOME SPECIAL CORES BY HAND FOR SHORT DISTANCES, AS WAS FORMERLY DONE

FIG. 3—ABOVE—THE SPRING WHEELBARROW HAS NOT BEEN REPLACED ENTIRELY FOR CARRYING CORES SHORT DISTANCES

Improves Handling Methods

Malleable Iron Firm Institutes Changes To Effect Economy—Many Gasoline and Electric Trucks and Tractors Supplant Hand Trucks and Reduce Labor—All Departments Affected by Changes

BY B. R. MAYNE

THE handling of raw and finished material is one of the greatest problems in the economic management of a malleable iron foundry. Fuel, raw material and products are all heavy. Foundry practice in earlier days utilized a large percentage of the plant personnel in the manual handling of these three factors. In making a study of the material handling methods used in the plant of the Saginaw-Malleable Iron Co., Saginaw, Mich., I compiled certain figures which are given in this article. Also we have found that as we have through the years supplanted manual labor with mechanical material handling equipment, we have steadily increased production and steadily reduced costs per ton of production; this in the face of rising labor costs.

The modernization of foundry practice and equipment is the answer to mounting labor costs. We cannot control the increasing price of fuel or material because the increasing labor costs are laid upon them at their source, but we can control costs during production, even in the face of advancing wages, by the installation of mechanical material handling methods and equipment.

The author, B. R. Mayne, is plant manager, the Saginaw Malleable Iron Co., Saginaw, Mich.

The work of our foundry is fully departmentalized. The cost accounting systems for each department are subdivided for definite operations. From the figures obtained from these definite operations, standard task hours are set for men employed in each group, and bonuses provided. The men and machines engaged in the handling of materials in these various departments are considered as members of the operating group and share in the bonuses earned by the group. For instance, on the foundry floor we have an operation known as *furnace repair;* this group is divided into four groups, one for each furnace. The operations of each group consist of the following:

Rebuild side walls
Repair bridge wall
Repair combustion chamber
Repair tapping spout
Repair power back
Screen bottom
Lay new bottom
Charge furnace
Put on bungs
Clean old mud from bungs
Mud up
General cleanup.

The furnace repair is made on Sunday so as to insure continuous furnace operation during the week. The night crew cleans out the furnace and gets it ready for the regular repair crew. It also hauls brick to the furnace. The day truck drivers are included in the bonus and are paid at the average efficiency of the four groups.

Description of the improved material handling methods which have been installed at our plant will be taken up according to departments, as follows:

Core room
Molding department
Melting department
Annealing department
Hard and soft iron rooms
Disposal of waste.

Core Room—The material handling problem in the core room is the bane of every foundry manager's life. We have replaced all the wheelbarrow men who formerly trundled sand to the core room, with a hand hoist, end-dump tractor. This is a three-wheeled gasoline powered vehicle which carries approximately 25 cubic feet of sand in its hopper. A tractor loaded with sand is shown in Fig. 6. The load is carried in front of the driver who is

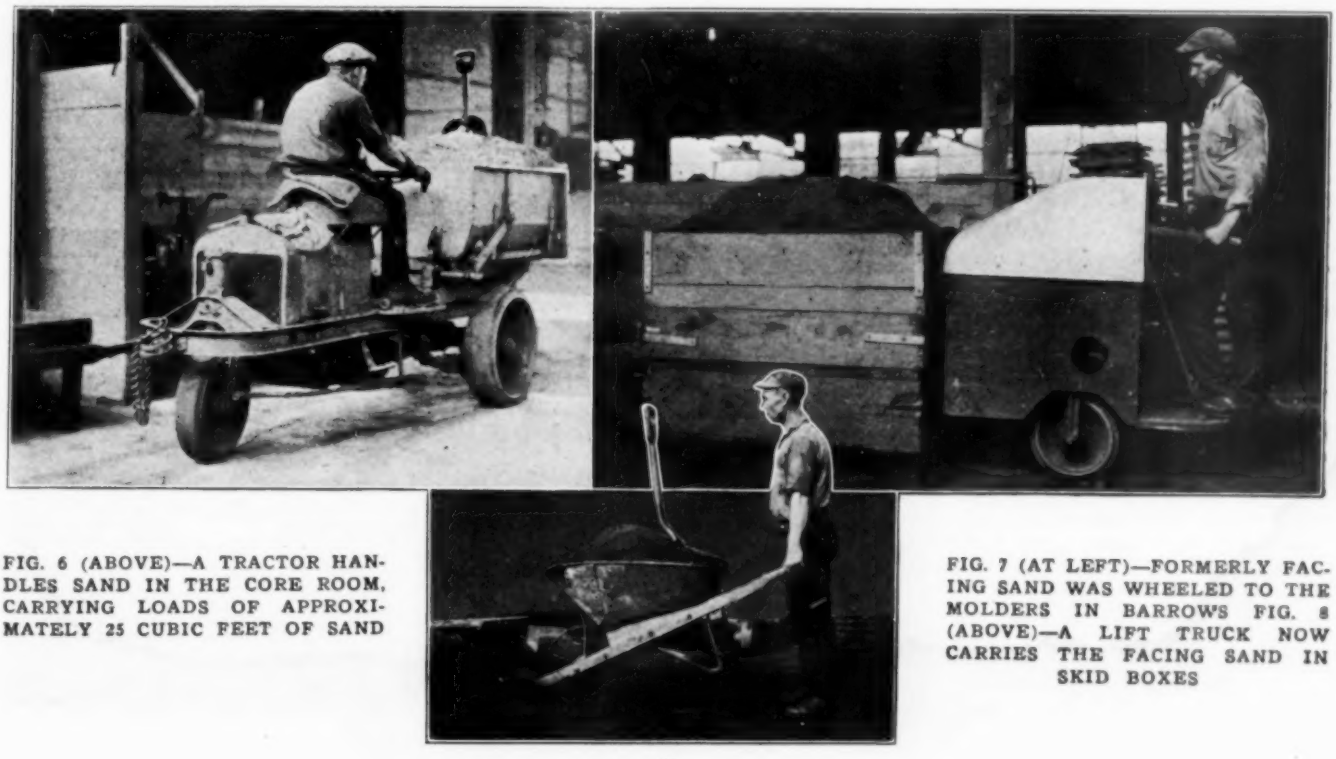
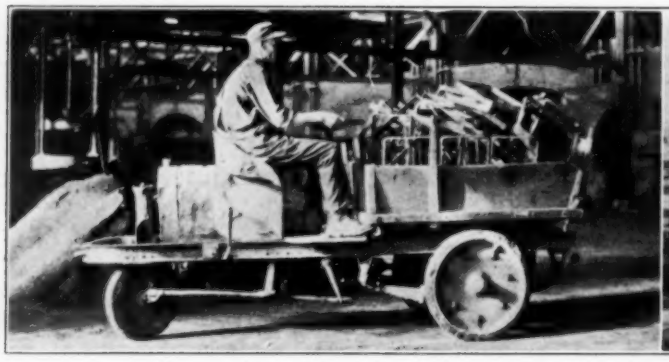


FIG. 6 (ABOVE)—A TRACTOR HANDLES SAND IN THE CORE ROOM, CARRYING LOADS OF APPROXIMATELY 25 CUBIC FEET OF SAND

FIG. 7 (AT LEFT)—FORMERLY FACING SAND WAS WHEELED TO THE MOLDERS IN BARROWS FIG. 8 (ABOVE)—A LIFT TRUCK NOW CARRIES THE FACING SAND IN SKID BOXES



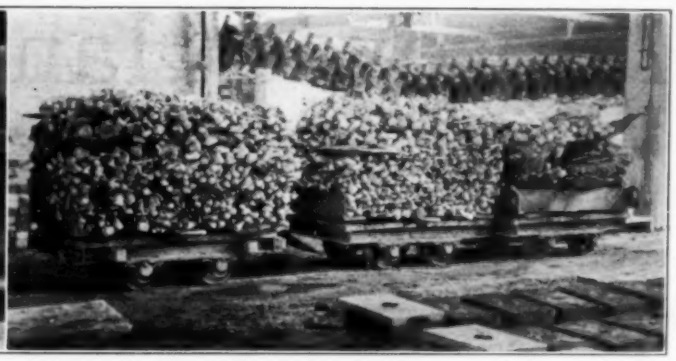


FIG 9—A GASOLINE TRUCK IS EQUIPPED WITH A CARGO BODY TO HANDLE EQUIPMENT NEEDED ON THE FOUNDRY FLOOR FIG. 10—PIG IRON AND SCRAP ARE HANDLED ON INDUSTRIAL CARS

thereby enabled to *spot* his load at any desired point in the room. We do not have at hand any definite data as to the savings over the use of wheelbarrows effected by this machine, but we do know that it has eliminated a great number of common laborers.

The cores as they come from the oven are extremely delicate. The nature of our production is such that we have found it necessary to provide storage for cores to meet the needs of quantity production. This entails an additional handling of baked cores and the ever present danger of breakage.

Operations Classified

Operations on core delivery, as classified by our standards department, include delivering cores from the core room to molders' floors and to racks in the foundry; that is, storage. The unit of measure is per thousand pounds of customers' good castings produced. This figure is taken from the daily foundry report. In old time foundry practice, cores were handled by hand; a good method where the handling distance is short, the men are careful, and speed is not a factor. We still utilize this method on some cores,

FIG. 11 (BELOW)—A TRACTOR MOVES THE ANNEALING CARS FIG. 12 (AT RIGHT)—FORMERLY POTS WERE PLACED IN THE OVEN BY A LIFT TRUCK

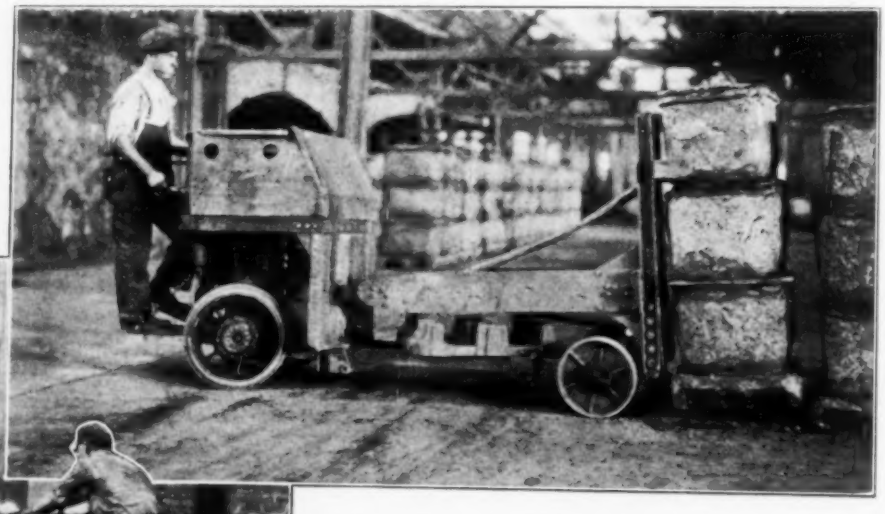


FIG. 13 (AT RIGHT)—POTS ARE LIFTED OFF THE ANNEALING CARS BY A HOIST AND THE CASTINGS DUMPED INTO THE BODY OF A TRUCK

as indicated in Fig. 5. We effected an improvement by building a three-spring wheelbarrow, Fig. 3. This enables us to carry cores comparatively safely for greater distances. The capacity per man is about the same as with the two-man trays.

We improved upon this method by building spring skids, which we carried on an electric lift truck, Fig. 1. This enables us to carry cores safely much greater distances, decreasing considerably the transportation cost per unit. The limiting factors to this method have been speed and the 8 hours of service obtainable from an electric truck on a single charging. However, it has been a great improvement over the manual handling of cores. A year ago we installed a gasoline powered industrial lift truck, Fig. 4, with an elevating platform of the same dimensions as the standard electric lift truck. This machine has given splendid service. It will lift and carry 4000 pounds, and has the advantage of being able to operate 24 hours a day. The capacity of both the gasoline and electric trucks is greater than the needs of the core room so far as weight is concerned. These machines will carry as many as 9 or 10 trays of the more substantial cores such as can be safely carried on springless skids, as indicated in Fig. 2.

Molding Department — Facings formerly were made in the foundry, utilizing for this purpose about two floors. They were brought into the central mixing place by wheelbarrow as indicated in Fig. 7. The molders would get their facing supplies from this central mixing and storage plant. The time of a molder is expensive compared with common labor, and much valuable time was lost by this method.

We now use skid boxes, 23 x 32½ x 50 inches, carrying 21½ cubic feet of facing. These boxes are distributed through the foundry, convenient to the work, by a gasoline driven lift truck, Fig. 8. The men take their shovels or riddle to the box. This saves the space of two floors which are now utilized for molding, and eliminates the waste time of men going long distances for facings.

Melting Departments — The foundry is laid out so that each furnace has its own yard. Pig iron and scrap are handled on an industrial track as indicated in Fig. 10. The cars are loaded in the yards and pushed to the furnaces. This is proving quite satisfactory. The men who load the pig push the cars to the furnace floors and this work provides a variation of occupation which takes the curse off the monotony of the task. Slag is removed from the pits by a gasoline tractor, which, because of its three-wheeled construction, is able to turn in the narrow aisles between the floors.

For the work of handling the various equipment needed on the foundry floor, we have one gasoline driven tractor equipped with a cargo body Fig. 9. This tractor does nothing but handle flasks, patterns, boards, bands, etc. This is under the direction of the foundry foreman and saves endless delays in the various operations.

Castings are dumped from the molds along gangways. Sprues and gates are knocked from the rough castings which are then piled at the corner of the floor or into skid boxes for carrying to rattlers.. Sprues and gates are now picked up in hand trucks, but we are planning to substitute a skid box and lift truck for this work. Rough

FIG. 14 (ABOVE)—CASTINGS FORMERLY WERE HANDLED BY HAND TRUCK FIG. 15 (AT RIGHT)—BRICK ARE CARRIED BY TRACTORS FIG. 16 (BELOW)—ANNEALING POTS TRAVEL ON ROLLER GRAVITY CONVEYORS

FIG. 17 (ABOVE)—AN END-DUMP TRACTOR NOW HANDLES CASTINGS FORMERLY CARRIED BY HAND TRUCK FIG. 18 (BELOW)—REFUSE IS TAKEN TO THE DUMP PILE BY END-DUMP TRUCKS

castings were formerly gathered from the pickup piles in three-wheeled steel hand trucks, 11 x 30 x 40 inches, which were then pushed or pulled by two or three men to the tender. The use of tote boxes and power platform trucks will enable us still further to reduce the handling cost here.

Annealing Department — The old annealing ovens formerly were charged by hand. Some years ago, we replaced hand labor by a forked lift truck which picks up the tiers of pots, and positions them in the ovens, as indicated in Fig. 12.

The old periodic ovens have been replaced almost entirely by a continuous annealing kiln. Small cars loaded with sealed pots containing the hard castings are fed into this kiln at regular intervals. New material handling equipment in this department has reduced the manual labor 75 per cent. The men in this department operate as a group. Included in their tasks are the packing of pots, loading of cars for annealing, dumping of pots, unloading cars after annealing, mixing mud for sealing pots, and keeping the department clean and in order. Truck drivers and all other men working on kiln operations, except oven tenders, are included in the bonus system.

Castings are packed into pots which ride on a roller conveyor to the loading point. The pots are then transferred from the conveyor by an overhead hoisting crane to a platform car where the pots are stacked and sealed. These operations are indicated in Fig. 16. The loaded cars are pushed along an industrial track, laid beside the oven by a tractor of the caterpillar type. The cars enter the kiln at the south end and are pushed through by a mechanical ram, which is part of the kiln equipment. Then they emerge from the north end of the oven when the annealing has been completed. A gasoline tractor is hitched to the car and it is pulled out of the oven on to the industrial track where the same tractor pushes it along to the unloading platform, as shown in Fig. 11.

The pots are lifted from the cars by an overhead hoist and the castings dumped into a hand hoist, end-dump gasoline tractor, Fig. 13, which carries them to the soft iron mill where the castings are rattled or sandblasted. Formerly, hand trucks were used for this purpose.

Hard and Soft Iron Rooms—The old method of handling hard and soft castings with hand trucks, Fig. 14, has been replaced by an end-dump gasoline tractor for long hauls, Fig. 17, and by a lift truck utilizing tote boxes and skids for short hauls and for storage purposes. The haul is about 300 feet. Time studies on the comparative costs of the hand and machine methods develop the following information:

With the hand truck two pots, 400 pounds each, are handled in each load by two men; thus one man handles 400 pounds.

With the gasoline tractor six pots are handled to a load by one man; or 2400 pounds per man.

The tractor makes 1.75 trips to every one of the hand truck, handling 4200 pounds to every 400 pounds, or 10½ times that handled by one man using the hand truck. The time study was made on one particular job. The ratio on other jobs will vary according to the distance, the greater the hauling distance, the more efficient the work of the tractors.

Fuel handling is not a problem at the Saginaw plant as oil is used. Fire brick, formerly handled from storage to furnace floor by wheelbarrows, is now handled by tractors, as indicated in Fig. 21.

Sand and waste from the foundry formerly were handled by wheelbarrows to an outside storage pile which, when large enough, was loaded into carts or trucks and hauled away to the dumps. This long line of wheelbarrow men has been replaced by tractors which are loaded on the foundry floor and run ⅛ to ¼ mile away to the dump where the load is quickly dumped, Fig. 18, and the machine returns for another load. Refuse sand removed from the rattlers and sandblast rooms formerly was removed by wheelbarrows, but now is handled from an overhead chute by tractors which carry it to the dump. Miscellaneous barrels, boxes and cases are handled by a reserve machine, ready for service at all times.

Our material handling equipment consists of our stationary conveyors, hoists, etc., and the following motorized equipment:

3 Electric platform lift trucks.
1 Electric oven charging truck.
1 Gasoline tractor of the caterpillar type.
10 Hand-hoist, end-dump tractors.
1 Cargo gasoline tractor.
1 Auto end-dump gasoline tractor.
2 Elevating platform gasoline lift truck.

Expense figures on our fleet of 14 tractors as compared with wheelbarrow operation are approximately as shown in the accompanying table. This would amount to a saving per truck-tractor per year of $8304.72, which, multiplied by the number of tractors in our fleet, shows why we have substituted mechanical handling of material within our plant for the manual handling of same. This amount is not entirely correct, because, while a great number of common laborers have been replaced, our motor vehicles are unable to perform other work in and about the foundry for which we are required to employ a large number of men. On the other hand we have found that our new methods of handling materials have enabled us to increase production.

Comparision of Operating Costs

Tractor Operation		Wheelbarrow Operation	
Interest on investment per month	$4.66	8 barrows at 12.50	$100.00
Depreciation per month	25.21	Maintenance per month	0.00
	29.87	Interest per month	0.72
(Life of tructractor—5 years)		Depreciation per month	20.00
Cost of repair parts	29.59	(Life of wheelbarrow—5 months)	
Operating expense:		Operating expense per month, 8 men at 40c per hour	864.00
4 gal. of gas at 18c (per 9-hour day)	0.72	Final total	$884.72
1 pt. oil (per 9-hour day)	0.12		
1 driver at 40c	3.60		
Total per day	4.44		
Total per month	133.20		
Final total	192.66		
Expense of wheelbarrows per month			$884.72
Expense of tractors per month			192.66
Savings			692.06

Care of Acetylene and Oxygen Cylinders

Air Reduction Sales Co., 342 Madison Ave., New York has issued an interesting 8-page folder containing a comprehensive series of instructions on what to do and what not to do in caring for and handling oxygen and acetylene tanks in commercial service. The scope of the subject covered may be gathered from a list of the paragraph headings which include: How to handle, avoid oil or grease, storage, keep in dry place, keep at normal temperature, store empties and fulls separately, use in order of receipt, cylinder cap, use a regulator, try valve, use no wrench on valve, keep sparks and flames away, don't repair leaky cylinder, don't use for a roller, don't refill, return promptly, pressure varies with temperature, manifolding cylinders.

Physical Factors Affect Iron

Hard Castings Ascribed to Chemical Content in Many Cases Are Due to Causes Other Than the Metal—Shrinkage Alleviated by Proper Gates and Risers

BY J. H. HOPP

CHIEF among complaints by foundrymen and buyers of castings, is that of *hard castings,* usually supplemented by the statement, *too high sulphur.* Therefore, your attention is called to such hardness as prevails only in a part of the castings made on a given floor and generally this exists chiefly in the lighter, that is, thin metal sections.

When reference is made to light castings, light weight castings usually are meant. This is misleading, as a casting may weigh heavily because of its size even when it has light sections. On the contrary, small castings upon examination many times have heavy metal sections. Without question, as far as metal is concerned we must treat with some difference these thin sections.

Referring to a floor of molds having thin metal sections, a portion of which are too hard for rapid machining, the cause is frequently found to be metal with a high combined carbon. This condition often arises from metal poured from the first iron melted, comparatively cold, wet or too damp sand bottom, green spout and most frequently green pouring ladles.

Should Dry Ladles

The practice of thoroughly drying all ladles by whatever means are at hand and further drying these ladles by the use of the first iron from the cupola is good practice, but it often appeals to the employer as being wasteful of a certain amount of molten iron, which, of course, after serving its purpose of further drying the ladles, is usually poured into pig beds.

The action brought about as a result of hot iron in a ladle which is not thoroughly dry is, as you all know, a boiling sort of action which is the result of the moisture being driven out of the lining of the ladle and escaping through the iron. The effect is to chill the iron and bring up the combined carbon.

It is hardly necessary to add that the use of molding sand which is too heavily wetted or the too generous use of the swab, will do likewise and when the moisture content is excessively great the resulting casting will be rejected irrespective of any hardness.

From numerous tests, little doubt exists but that the first iron from the cupola, under average conditions, is inclined to contain a preponderance of molten scrap metals because of their tendency to melt faster than the heavier metals, such as pig. Naturally, an analysis of this metal will show somewhat higher in sulphur than the average sulphur shown in succeeding taps. However, as a rule, the hardness attributed to the first iron is more likely to be due to physical conditions than the elements in the metal.

Sulphur probably gives the average foundryman more concern than any other one element and in talking with hundreds of foundrymen there is quite a difference of opinion as to what is considered high sulphur. Knowing that many foundries produce castings which are readily machineable although the content of sulphur runs from 0.125 to 0.175 per cent, and in some cases higher, we must conclude other factors cause hardness. It is true that a metal having a sulphur content such as has just been quoted must have the other elements in such proportions as tend to offset the hardness that would ordinarily be brought about by so high a content of sulphur. Therefore, we look for assistance from a higher silicon content and a better proportion of manganese than most foundries are inclined to carry, as well as a higher total carbon and invariably this means a lower phosphorus content.

Causes of Hard Spots

Many castings have come to the attention of the writer which were readily machineable on the whole, but certain parts of such castings were practically nonmachineable. To suggest that the cause of this hardness was in any way due to the chemical proportions of the metal would be to misplace the blame.

Shrinkage manifests itself in various forms and places, but generally shrinkage follows some well defined line and while it is not believed that the examples given will entirely reduce shrinkage, nevertheless it is a fact that shrinkage cannot all be attributed to the chemical constituents of the metal. It is believed that many times shrinkage of a certain character has been eliminated by pouring colder iron. Of course, this is truly a mechanical method and can best be explained by a simple statement that shrinkage invariably occurs where unequal sections of metal adjoin one another, and is the result of the heavier section remaining unsolidified for a greater period of time than the lighter section. By cooling the iron considerably after first having taken the preventive measure against possible misrun, of gating the casting at the point of thinner metal, and even carrying this gating to the extreme, there is a fair possibility of equalizing to a large extent the rate of cooling of the two sections.

At times it has been further necessary to alter the method of molding—that is, to reverse the pattern and place in the cope portions of the castings which previously had been made in the drag, either because the patterns were so furnished or because the foreman or the molder felt that the method adopted was more simple.

How Risers Help

No doubt, risers in one form or another do assist producing better castings. Sometimes these relieve pressure on the mold, but more generally, to use the molders' expression, rises feed the heavy part. Such practice it is believed, cannot be entirely discarded. On the other hand, when 10 or 20 castings are made off of a given pattern it must follow that the difficulty of treating these individual molds becomes increasingly difficult if each riser has to be fed carefully and churned or fed to be certain that the metal has been kept in a molten state and that hot iron has been added to fill up the voids.

The results obtained from the use of a riser or risers, as observed in hundreds of cases, indicate that the use of the riser in many cases has been carried to an excess. Making sound castings, that is, castings free from shrinkages, can be benefited greatly by chemical control of the elements, but even under conditions of suitable mixture one must resort to his mechanical ingenuity. Of course, many older foundrymen will recall vividly the days when little or nothing was known about the component parts of iron from a chemical standpoint, yet sound or reas-

Abstracted from a paper presented at a meeting of the Chicago Foundrymen's club. The author is vice president of the Charles C. Kawin Co., Chicago.

onably sound castings were made that were acceptable either in the shops or by the purchasers. The automotive industry has demanded of the foundrymen, and this demand has been reflected in the demands of other manufacturers, a higher degree of perfection than generally prevailed prior to the time this industry commenced to assume large proportions and before the time of intense production.

While on this subject of shrinkage, attention should be given to the practice of gating the casting chiefly with respect to its position in the flask, bar interference or what not, with the possibility of setting the gate at a mechanically convenient point without regard to the metal section of the casting where the gate is attached. Most frequently it is found that the casting is gated on the heavier sections. All agree that we must gate a casting for its thinner sections of metal as the heavier sections will take care of themselves. This applies to gray iron.

In every shop there is produced each day a quantity of castings which upon machining disclose the presence of dirt. Chemically, I do not profess to be able to answer for this condition. Physically, it has come to my attention that two general causes are responsible. One of these—the lesser cause—is equipment. This not only includes patterns but core boxes and driers. By far the greatest cause of dirty castings is too great an area concentrated in a single gate. It must be evident that if you use a gate 1 inch wide by ½ inch deep that there is a greater possibility of dirt or slag, which may find its way through the down gate, entering the mold through such a large area than if this total area had been divided into four gates, each 1 inch wide by ⅛ inch deep. Even such an arrangement cannot be a remedy where other conditions of various kinds which demand attention and correction exist.

New Catalog of Sand and Foundry Supplies

Whitehead Brothers Co., New York, Providence and Buffalo has issued a new catalog of sand, supplies and foundry equipment in an attractive volume 10½ x 7½ inches, 357 pages, printed on heavy coated paper and bound in heavy cloth covers. The material in the book is designed for the use of the purchasing agent and the man in the shop and is presented as an aid in solving the problems and answering questions that arise in regard to the source of foundry sands, supplies and equipment. It is stated that the purpose of listing pieces of equipment made by many prominent manufacturers is to obviate delay or trouble incidental to looking up several sources of information. The section devoted to a description of the various grades of sand is illustrated by micrographs showing the grain characteristics of each variety, and by the chemical, rational and mechanical analysis of 10 different grades of sand.

Useful information in connection with sizes, capacities, linings, speeds, gages and methods of operation, are set forth in the section devoted to cupolas. A somewhat similar method is followed in the description relating to core ovens, molding machines, cleaning room equipment, hoists, riddles, small tools, sandblast, grinding machines, pattern shop equipment and supplies. Several pages at the back of the book are filled with miscellaneous tables and a comprehensive index.

Submit Brass Crucible Standard Sizes

The Plumbago Crucible association has submitted its standard sizes of brass crucibles for approval by the American engineering standards committee. These standard sizes were developed under a committee originally under the auspices of the American Institute of Metals, consisting of representatives of users and of crucible manufacturers, the work having been begun in 1913. In 1915 the committee completed its work by the selection of certain sizes then made, recommending these for adoption as standards. In 1919, at the instance of the American Institute of Metals, a vote was taken on the formal approval of these sizes as standards, but they were never put into actual use, on account of disagreement regarding the selection of sizes on a purely arbitrary basis.

As a result, one of the members of the Plumbago Crucible association was employed to work out a definite and comprehensive plan of standard sizes. This was done on the basis of the shape that had become established through long usage, and in a series in which every size of crucible bore a definite relationship to every other size, and was susceptible to calculation of its capacity by the same formula. In working out the series, certain adjustments were made to avoid confusion with existing sizes and to permit specifying, as nearly as possible, the same size number in the new line of crucibles as had been the case, on the average, in the old unstandardized sizes. All but two crucible manufacturers who make crucibles for brass foundry use, have made molds to conform to the new sizes. Under this system the product of every crucible manufacturer will have the same outside shape, so that wherever they are used, the tongs and bails will fit, regardless of the source of supply.

These standard sizes were given in THE FOUNDRY, July 15, 1923.

Symbol Designed To Cut Machining Losses

Acting on the assumption that if the preliminary cut is taken from the cope side of a casting, the operator will be in a position to determine whether or not further machining is justifiable, the Standard Symbol & Pattern Letter Co., 445 Green Lane, Philadelphia, has started a campaign to have a suitable mark placed on the cope side of every casting. Believing further in the value of standardization it has prepared a suitable symbol in the shape of a six-point star with a raised letter C in the center and is prepared to furnish the device to any person who may be interested. The star is ⅞ inch wide across the points and the letter is ⅜ inch. The combined thickness of both is ⅛ inch and, therefore, it does not disfigure a casting even if it is allowed to remain. In cases where the surface is machined the little additional patch easily is removed.

It is claimed that in the great majority of machine shops the machine operators are not sufficiently familiar with foundry methods to determine which is the cope and which is the the drag side of the castings delivered to their machines. In fact, after the castings have been cleaned and ground, no evidence remains to show which side of the casting was molded in the drag. With the strange perversity which seems to characterize inanimate objects the casting usually is placed in the machine in such a manner that the drag side is machined first. Later, when the cope side is machined, defects may develop sufficiently serious to condemn the casting. It is apparent that if the cope side had been machined first, the time and expense might have been saved.

Lee R. Wetherill, the originator of the idea which is protected by copyright, is seeking to enlist the support of the joint committee on pattern standardization sponsored by the various associations interested in the metal working industries.

Casting Steel Tools to Shape

Methods and Theories by Two Firms Manufacturing High Speed Steel Tools Which Were Cast to Approximate Size Are Presented and Discussed by a Metallurgist Familiar with the Processes

BY J. M. QUINN

SEVERAL concerns, other than the one with which the writer was identified, have been more or less successful in casting high speed steel tools. It is interesting to know what two of these companies thought of this process and how their metal was produced. As some of the statements made by these companies relative to this subject are contrary to what the writer believes, some notations in *Italic* type are offered which bring out certain points. It is hoped these statements will bring forth some discussion.

The summary of the method employed at the one plant relates particularly to high speed steel alloys, as distinguished from the ordinary alloys of steel, which are determined largely by their content of carbon. All such high speed steel, when poured, show a characteristic form of microstructure of the dendritic type or pattern[1], with the narrow fern-like or tree-like crystals (dendritic) of carbide surrounding or separating the crystals of the softer eutectic matrix. The sharply defined carbide structure stands out in coarse plate-like crystals, and must be broken down[2] and put into solution or diffused in the matrix to properly transform the steel into a final hardened martensite state, suitable for use as cutting tools.

1—*All high speed steels as cast* have approximately the same cellular structure or carbide envelopes and no one would attempt using the steel as a tool while in this condition. This is indicated by the micrograph, Fig. 1. If the casting temperature is too great a highly dendritic structure will result. This structure which is naturally weak cannot afterwards be obliterated either by heat treatment or even by mechanical working of the steel. The exact chemical formulas of these carbides are unknown but probably are mixed complex tungstides and carbides of iron, chromium and vanadium.*

2—*This is true. The high speed ingot is first annealed primarily to assist in modifying the cellular structure and to remove internal strains. The effect of hammering and reduction breaks up the coarse structure, refining and distributing the carbide and tungstide particles throughout the mass of the steel, as Fig. 2 indicates.*

Unless the carbides are thoroughly dissolved and transfused, such a steel would chip out and disintegrate, due to the localized and interspersed plates of carbide. It, therefore, has been necessary in such steel to reduce the structural forms of the castings by physical distortion, and heat treatments. Such treatments[3] like forging, rolling and hammering with intermediate steps of annealing, break down and lay the crystalline formation so that the final bars of metal have a more or less fibrous silky texture.

3—*The chief source of trouble with ordinary high speed steel when making large milling cutters, hobs, etc., * which cannot receive as much work as say a lathe twist drill, is invariably found to be due to the presence of laminated carbide lines. These carbide lines which are forged out and elongated segregates formed from the melt, are most difficult to eliminate when once formed.*

Even in this form articles made from the metal must be given heat treatments or tempering to bring them up to the proper degree of hardness, to serve as cutting tools. The structure is one which entirely lacks true crystalline formation of uniform character, as any such structure is dependent upon the breaking and distortion of the actual crystalline forms of the alloy. As is well known the separation of the carbides and other crystalline forms in such a cooled alloy is termed ingotism.

It is one of the objects of the present process to produce a high speed steel, having in mind the dissolution[4] of the highly refractory elements, such as carbides which are formed during the fusion of the metals. It also is the object to secure a more perfect admixture to produce a steel which when poured requires no physical treatment such as forging, etc. to place its crystalline forms into the desirable martensite[5] form of structure; in fact, no treatment other than such final heat treatments or tempering as is given finished cutters or tools.

4—*A perfect solution of the carbides in this steel has not yet been attained even by the cast method* as indicated by Figs. 3 to 6. However a better structure and mixture of the alloys is usually obtained with the cast method than with many high speed steels made by other processes.*

5—*The martensitic structure is only obtained by heat treatment and is desired by all high speed steel tool makers.*

In the making of high speed steels it has been customary to employ a substantially pure iron or steel base having a definite carbon content. The production of this steel, therefore, has been attended with high cost and many failures due to inherent impurities[6] and contaminating elements both in the iron base and in the alloying elements introduced. A high speed steel scrap can be used and a resultant analysis secured with a higher content of carbon, silicon and manganese, than is shown in the ordinary high speed steel[7] made under the most favorable conditions with material of purity.

6—*This statement is contradictory as a substantially pure iron or steel base would not contain contaminating elements. The amount of impurities in ferroalloys is within reasonable control and is usually only a matter of purchasing alloys of an analysis which will meet requirements.*

7—*A charge of all high speed steel scrap can also be used for the usual high speed steel process and the carbon, silicon and manganese contents readily increased beyond the usual specification, if so desired.*

Advantage is taken of the peculiar characteristics of certain of the elements, by introducing in the total content definite increments, and in conjunction with other of the alloying materials. Thereby producing complex or compound carbides in a form which is really an alloy of the carbides, and a compatible correlation with alloys of the true metallic elements thus securing the desired end.

The author formerly was superintendent of electric furnaces, U. S. High Speed Steel & Tool Corp., Troy, N. Y.

No. 1 *Bulletin No. 7, Detroit Twist Drill Co., Detroit.

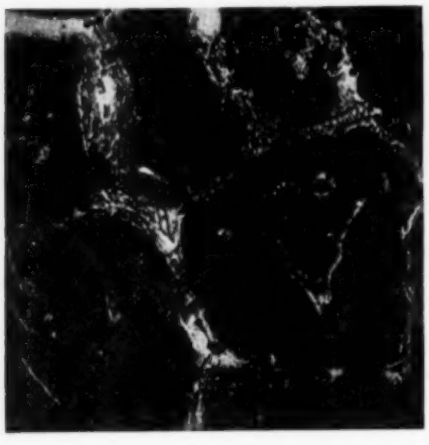
***The Manufacture and Working of High Speed Steel*, by Andrew and Green.

**The Properties of High Speed Steel*, by G. J. Horwitz. This paper was presented before the New York section of the American Steel Treaters' society, June 20, 1919, and includes the micrographs shown in Figs. 3 to 6.

It has been found that desired results can be secured even with considerable variation in the content of tungsten, carbon, vanadium, manganese and chromium in the production of this high speed steel, and that the contents of these elements may be further varied by using molybdenum, zirconium or uranium. For example an alloy having the following analysis has the desired properites for this high speed steel:

Carbon	0.70
Manganese	0.50
Vanadium	0.75
Chromium	4.00
Tungsten	18.50

Variations in the content of tungsten, vanadium, manganese or chromium or the introduction of other elements have of course, a distinct influence, although the final structure of this steel bears the same general characteristics.



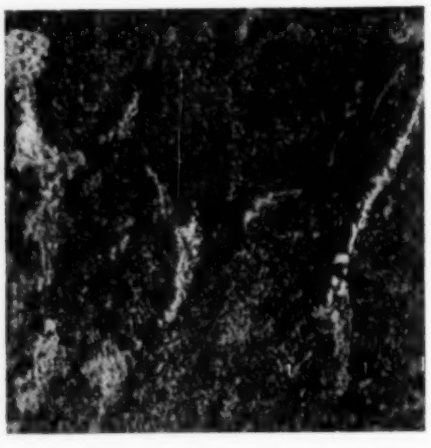


FIG. 1—MICROGRAPH OF A HIGH SPEED STEEL INGOT "AS CAST," SHOWING THE COARSE CELLULAR STRUCTURE. FIG. 2—ANNEALING AND FORGING REFINES THE METAL

It has been almost impossible heretofore to make a sound casting from tungsten steel. Such steels have a fine crystalline structure, but tungsten has been used sparingly, usually not in excess of 3.00 per cent tungsten, with a resultant steel difficult to work and temper. The percentage of tungsten has in some cases been increased in ordinary high speed steel, but in this process it is possible to carry it up to 19.50 or 20.00 per cent*, still securing the characteristic fine crystalline structure. This large content of tungsten can be used because of the control of the carbon content and using vanadium and chromium in the presence of titanium with suitable fluxes. Vanadium[9] is employed to counterbalance the tendency of chromium to oxidize and form slag. Further loss of chromium into the slag is prevented by introducing manganese which serves its purpose as a deoxidizing medium at the same time forming a direct alloy. It also serves its purpose in unifying the crystalline formation when the metal is slowly cooled down.

8—*Tungsten has less influence on the structure than carbon. *However, the action of tungsten in the absence of chromium, is to raise the temperature at which tempering or annealing begins, while in the presence of chromium, it increases the secondary hardness which is brought about by low heat treatment. Chromium increases the solubility of the tungsten carbides to such an extent that with 6 per cent of the former element, 19 per cent tungsten can be held in solution at 2460 degrees Fahr.*

9—*It is exceedingly expensive to use a $5.00-a-pound alloy like ferrovanadium to retard the oxidation of a $0.50-alloy like ferrochrome, and with such poor furnace practice much of both alloys would be oxidized and lost. Having a good reducing slag is preferable and only a small percentage of the chromium is lost when added under this condition. This last remark also applies to the ferromanganese addition.*

A normal excess of carbon[10] is provided during the melting of the scrap and alloys, and this element is built up with the intention of producing certain carbides of chromium, vanadium, tungsten and manganese. These commodities, during the alloying of the metals, go into solution and combine for the purpose of producing what might be termed a carbide alloy, which will have a eutectic point comparable with the eutectic of the alloyed elements. Thus segregation, or ingotism, which has been such a serious obstacle in ordinary high speed steel, is avoided.

10—*This statement about a normal excess of carbon is misleading as an excess of carbon under good furnace conditions would bring the final carbon above the desired percentage. Should this excess carbon be necessary to help deoxidize the melt it would indicate poor furnace conditions, or oxides in the charge. But the final carbon in cast high speed steel is intentionally made higher than in regular high speed steel for rolling.*

With the foregoing preliminary explanation in mind, the following will give an illustration under the most trying conditions, that is, using approximately 200 pounds of high speed steel scrap, with 100 pounds of iron, showing an analysis quite different, and a further content of 250 pounds of iron, and illustrates the building up of the carbon, silicon and manganese contents[11]. With foregoing the following elements are alloyed: Approximately 110 pounds of 80 per cent tungsten having an analysis of 1.00 per cent carbon and 0.60 per cent silicon; 14 pounds of 40 per cent vanadium having an analysis of 0.50 per cent carbon and 0.50 per cent silicon; 42 pounds of 60 per cent chromium having an analysis of 0.60 per cent carbon and 0.50 per cent silicon. With these materials, a silicon-aluminum-manganese flux is used which in the aggregate brings the carbon, silicon and manganese contents approximately up to 3.9 pounds carbon, 2.4 pounds silicon, and 4.7 pounds of manganese. In order to increase the carbon content, carbon is added to bring the working carbon content up to approximately 5.7 pounds of carbon. With these contents in mind, the final analysis of the alloy with its carbon content considerably less than 1.00 per cent indicates the activity of the carbon in the formation of carbides and in graphite dissolution.

11—*Note the accompanying table where these scrap and alloy additions are listed. It seems reasonable to believe that large percentages of vanadium, chromium, and probably other alloys, are oxidized and lost when the slag is removed. Otherwise it would not be necessary to duplicate these additions later in the operation to secure the desired final analysis.*

The furnace is charged with the iron and tungsten to which preferably is added a small content of molybdenum, or approximately 1 pound, then deoxidizing the mixture by raising the temperature above the normal fusion point of the combined alloy of iron, tungsten and molybdenum. When the metal is melted a content of vanadium is added equal to approximately 4 pounds. When the steel is deoxidized further addition is made of approximately 42 pounds of chromium in the

**The Properties of High Speed Steel*, by G. H. Horwitz.

presence of ferrotitanium. An immediate reaction occurs with a rise of temperature which is increased beyond the normal rise resulting from adding the titanium. Of course, it is understood that the initial charge of iron, tungsten and molybdenum is covered with a suitable slag-making material of lime, etc. After the ferrotitanium has been introduced the metal is slagged off[12], and a new content of lime, etc., added.

12—*After all these metallic deoxidizers had been added a good slag should be obtained provided reasonable skill and care had been taken with the operation. Now if such conditions were attained, there does not seem to be any reason for removing a good slag and exposing a readily oxidized metal to the atmosphere at a time when it should be well deoxidized.*

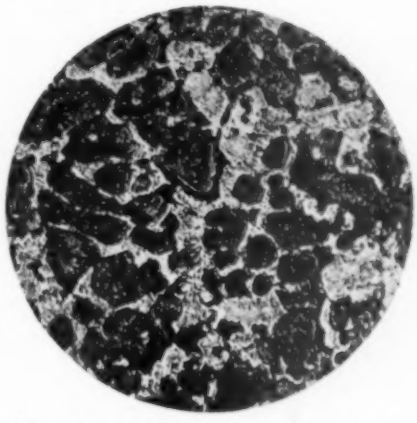
After the mixture with its chromium and titanium has been thoroughly mixed, a content of manganese is added in the presence of silicon and aluminum. This thoroughly cleanses or scavenges the steel, the silicon reducing the basic materials or impurities, while the manganese in part combines and in part finds its way to the slag. The aluminum in the combination acting almost as a thermite producing great liquidity, and through its deoxidizing action, permits an immediate and perfect union of the various metals of the alloy. After the mixture is completely cleared of reaction a content of approximately 10 pounds of vanadium is added in the presence of a further content of titanium. This produces a quick deoxidization and purification, and the titanium materially aids the absorption of the vanadium in the steel. There is, of course, a sharp rise of temperature following this introduction, and as soon as this subsides, a further reaction is given to the now alloyed materials by introducing what might be termed a thermite purifier, consisting of silicon of calcium, manganese, silicon and aluminum[13]. The metal after remaining at a high heat for a short period is slagged off and poured.

13—*Using large quantities of metallic deoxidizers will cause excessive shrinkage in the final cast tool or ingot, and the steel will not be a good product.*

It may be noted that the full content of vanadium is introduced in two stages, immediately after the tungsten has been alloyed, and again in conjunction with titanium. The titanium also is introduced in two stages, notably with the chromium and with the last addition of vanadium. This aids in the production of the various composite carbides as well as in the absorption of the chromium, vanadium and tungsten. Little or no titanium shows in the final analysis of the steel. It may also be noted that a working content of carbon is built up in the furnace as the various elements are introduced, all of which contain varying contents of carbon. To insure the maximum carbon content, pure carbon is added to such an extent as may bring the content up to approximately 5.7 to 5.9 pounds of carbon. It also will be obvious that the normal manganese content of the metal is increased by introducing manganese in the presence of silicon and aluminum, thus taking advantage of its solvent and deoxidizing attributes, its ability to form carbide, and its peculiar ability to aid in the alloying of tungsten and other metals pos-

Effect of Heat Treatment on Tool Steel

Fig. 3.—Left—Annealed at 1500 degrees Fahr. and air cooled, showing a coarse, cellular structure Fig. 4.—Right—Annealed at 1350 degrees Fahr. and furnace cooled. The structure is finer that that of Fig. 3, but still cellular.



The accompanying micrographs show samples of high speed tool steel subjected to different heat treatments. The metal contained 0.93 per cent carbon, 5.07 per cent chromium, 1.50 per cent vanadium, and 21.02 per cent tungsten. All samples were etched with nitric acid and ortho-nitro-phenol—Magnified 500 dia.

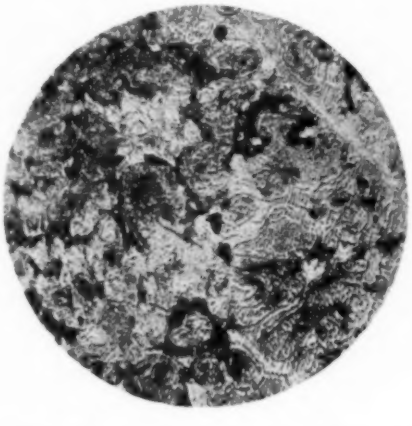


Fig. 5.—Left—Annealed at 1800 degrees Fahr. and furnace cooled. The structure is sorbitic and contains double carbides Fig. 6.—Right—Annealed at 1350 degrees Fahr. and furnace cooled, then quenched in oil from 2300 degrees Fahr.—The structure is martensitic (dark) and austenitic (white) with unabsorbed double carbide eutectic.

sessing comparatively high melting points.

This steel made as described has unusual characteristics. It may be poured and cast from the furnace and will fill the molds perfectly even to intricate patterns of cutting tools, and only requires grinding and heat treatment or tempering to provide the highest grade cutting tools. The microstructure[14] is of the martensite form.

14—*Final structure of the steel depends to a great extent upon heat treatment given the steel. All high speed steel has a martensitic structure when heat treated properly and the carbides substantially in solution.*

The procedure followed by another manufacture relates to the production of castings especially for milling cutters, reamers, countersinks, bar stock for lathe tools, mills, etc., which will be tough, homogeneous, free from blow holes, gases and other impurities to such an extent as to be adapted for use after finishing and heat treatment, without the necessity of rolling, forging or hammering. By this process it is possible to produce a wide range of alloy steels in the form of castings at a great saving in cost as well as improvement in quality, especially in semi and regular high speed steels, as compared with the best forged, rolled or hammered steels now on the market.

The ordinary scavenging treatment with silicon, manganese, etc., for removing impurities in the electric furnace just before pouring is ineffective[15]. This is evidenced by the weakness and lack of uniformity of the castings due to blow holes, slag, carbon, other impurities, and crystallization due to rapid solidification found in cast steel tools ordinarily produced. Also there is variation of analysis in different parts of the same casting and loss of expensive alloying metals used. Thus for vanadium, ordinarily a loss of 50 per cent[16]. and upward occurs, whereas by this process the loss can be between 20 to 30 per cent which effects a decided saving in this expensive material. Again, the percentage of usable castings from a melt is important because alloy steel is expensive at best and a high percentage of loss increases the cost of the remainder. Furthermore these figures are affected by the amount of metal lost from a usable casting in the head or risers, so that it is desirable to reduce this loss as much as possible.

15—*Ordinary methods of deoxidation have not the desired effect and unusual treatment is necessary before high speed steel should be poured into tool form castings.*

16—*Any manufacture of high speed steel loosing 50 per cent or more of the vanadium added had better change their furnace practice. In the electric furnace, the loss of vanadium should be less than 10 per cent of the amount added, provided it is given a fair chance to alloy with the metal.*

By this process, day to day results in a commercial foundry producing form tools such as milling cutters, etc., in sand molds, show over 90 per cent usable castings, with 30 per cent or less for heads as compared with ordinary steel foundry practice using a head equal to or greater than the casting, and having a much lower percentage of good castings. In many castings risers are done away with entirely. This process enables these results to be obtained by producing a tough, dense and homogeneous steel when set and of extreme fluidity when poured. The tools may be cast within 0.015 inch of surfaces, enabling finishing to be done by grinding with a large saving in the labor cost. They also can be heat treated according to usual practice.

The melt[17] is made up of iron, tungsten and chromium in any desired manner so as to secure complete alloying. These materials are melted, and the temperature is raised much higher than the melting point. The high temperature is continued for 30 minutes or more. A quantity of scavenging deoxidizing mixture contains some or all of the silicon, titanium, vanadium, manganese, aluminum, etc. as desired. Alloying metals such as cobalt, zirconium, molybdenum[18], uranium, etc., which otherwise would be volatilized or oxidized and lost can now be added. The vanadium used at this time is for scavenging and not for alloying as alloying vanadium is added later so as not to be oxidized. In ordinary practice the melt would now be kept in the furnace for a short time and then cast in an ingot mold, but could not produce satisfactory or uniform cast tools. Cast ingot steel of suitable analysis then is hammered, or rolled, and annealed, and finally machined into tools at considerable expense. For cast form tools or bar cutting stock additional refinement is necessary to eliminate oxides, gases and other impurities.

17—*The original charge of scrap and alloys should be so low in sulphur and phosphorus that these elements should not be considered at any time during the process as entering the reactions except to a small degree. However, other oxides like iron oxide, and also gases are in the metal*

Charge and Additions for Cast High Speed Steel

Commodities	Pounds added	Carbon Per cent	Carbon Lbs.	Manganese Per cent	Manganese Lbs.	Silicon Per cent	Silicon Lbs.	Vanadium Per cent	Vanadium Lbs.	Chromium Per cent	Chromium Lbs.	Tungsten Per cent	Tungsten Lbs.
Charge of iron and scrap													
High speed steel scrap	200	0.70	1.4	0.50	1.0	0.30	0.6	0.24	0.5	4.00	8.0	18.50	37.0
Iron or steel scrap	100	0.50	0.5	0.45	0.4	0.09	0.1	...	...	...	...	...	...
Iron scrap	250	0.12	0.3	0.34	0.9	0.04	0.1	...	...	...	...	...	...
Alloy addition with iron and scrap													
Ferrotungsten	137	1.00	1.4	...	...	0.60	0.8	...	...	...	...	80.00	109.6
Ferrovanadium	14	0.50	0.1	...	...	0.50	0.1	40.00	5.6	...	...	...	...
Ferrochromium	42	0.60	0.2	...	...	0.50	0.2	...	...	60.00	25.2	...	...
Silicon, aluminum, manganese flux	1	...	...	...	...	50.00	0.5	...	...	...	...	...	...
	3	...	...	80.00	2.4	...	...	...	...	...	...	...	...
First preliminary total	747	0.52	3.9	0.62	4.7	0.31	2.4	0.82	6.1	4.32	33.2	19.63	146.6
Carbon additions	2	90.00	1.8	...	...	...	...	...	...	...	...	...	...
Second preliminary total		0.76	5.7										
Alloy additions after melting													
Ferrovanadium	4	0.50	0.0	...	...	0.50	0.0	40.00	1.6	...	...	...	...
Ferrochromium	42	0.60	0.2	...	...	0.50	0.2	...	...	60.00	25.2	...	...
Third addition of alloys													
Ferrovanadium	10	0.50	0.0	...	...	...	...	...	...	...	...	...	...
Final total with no allowance for alloy losses	805	0.74	5.9	0.59	4.7	0.32	2.6	1.46	11.7	7.30	58.4	18.55	146.6
Deducting final analysis desired		0.70		0.50		0.30		0.75		4.00		18.50	
Leaves an excess of elements for losses		0.04		0.09		0.02		0.71		3.30		0.05	

for elimination.

18—*Some of these ferroalloys like colbalt and molybdenum are preferably added with the scrap charge. When there are proper furnace conditions, a small quantity of these alloys is lost by oxidation.*

After the last mentioned, alloys such as cobalt, etc., are added, oxidation of the alloys is prevented by another treatment with the same mixture, at the same time holding the temperature of the metal high during 30 minutes or more. The temperature is now dropped and a charge similar to that before used is added, except that it is somewhat less than one-half as much and contains some iron[19] scale. Tantalum[20] amounting to a certain percentage of the melt preferably is added to this charge. These additions are in packages tied to iron rods so as to be inserted by the melter at the bottom of the electric furnace. The metal immediately becomes more fluid and quiets down as the heat[21] is again raised to a high point and maintained for 10 minutes. Alloying vanadium can now be added, with only an allowance for loss as stated of 20 to 30 per cent[22] at the same time maintaining say a slightly lower temperature for about 10 minutes.

19—*Dropping the temperature during deoxidation with ferroalloys is good practice but why anyone wants to add even a small quantity of iron oxide, at a time when the metal is nearly free of oxides is beyond the writer's understanding of metallurgy.*

20—*Tantalum is an expensive deoxidizer and probably cheaper alloys will do the work equally as well. Dr. Kelley of the Midvale Steel & Ordnance Co., says that from its position in the periodic table, tantalum might be expected to show effects similar to those of vanadium.*

21—*The temperature of the metal is increased only slightly by these alloy additions. It is not good practice to heat up the metal at such a time in the process.*

22—*Excessive loss of vanadium already mentioned.*

The bath should now be quiet and appears to be free of impurities but such is not the case, as has been found from experience. The addition of further scavenging materials at this time would have some effect but the chemical action alone will not completely clear a bath of this character at this high temperature without the risk of removing some of the valuable alloying metals desired in the final analysis. A violent, almost explosive action is required[23] which acts mechanically as well as chemically to expel the residue of oxides, occluded gases, slag, fragments of brick from the furnace lining (which sometimes adhere to the side of the furnace below the surface of the bath), sulphur and phosphorus. The treatment at this time also has the function of increasing the fluidity of the bath and must be of such character as not to introduce objectionable matters into the metal.

23—*On this point the writer does not agree, as other means of agitation undoubtedly are just as good, such as gentle stirring of the bath with a steel bar at certain intervals.*

After holding the temperature high, a mixture of alloys of silicon, manganese, aluminum, titanium, and magnesium, is added together with a small percentage of iron oxide.[24] This mixture being composed partly of finely powdered alloys and partly of lumps, and varying in composition according to necessity and the analysis. As a general rule about 50 per cent will be lumps of about the size of nuts, and the metallic aluminum will be in small lumps. The action of this mixture of lumps and powder may perhaps be explained by assuming that as soon as the covering of the package is consumed the powder goes off, first with a comparatively violent reaction, which is immediately followed by the larger reaction due to the mass of lumps. The reaction results in what is practically an explosion at the bottom of the furnace, which not only violently disturbs the bath causing occluded gases to pass out, but also carries away any solid impurities and thoroughly mixes the entire bath. Heretofore in high speed steel it has been difficult to obtain large castings of uniform analysis owing to the different specific gravities of iron, tungsten, chromium and vanadium. But after this explosive scavenging action, there is not only a substantial freedom from sulphur, phosphorus, oxides, gases, slag and other impurities, but also a complete formation into a homogeneous alloy. If an electric furnace is being used the metal now can be poured from the furnace and is ready for the molds.

24—*One of the aims of all steelmakers is to free the metal from oxides by the end of the operation, yet iron oxide again is added. Iron oxide is one of the most injurious elements in steel.*

The molds are so made that the surfaces are cast within 0.015 inch of the finished tool and in most instances only requiring to be finished by sand blasting, or light grinding. Where cutting surfaces are to be ground to finish, it is preferable to allow somewhat more than 0.015 inch extra. As above stated in many instances risers are omitted entirely where before they were universally required. The heads are made small because the metal in setting in the mold has an unusually prolonged period of solidification or semisolidification, without forming pipes and without shrinkage. The fractures[25] are characteristically different in both color and texture and the steel seems to have a fineness and fiber unlike other steels, either cast or forged, which have a similar analysis. A peculiar herringbone formation has frequently been observed which is quite distinct from anything before observed in cast steels. Little or no variation occurs between the outer and the interior structure of the casting nor is there variation in the cutting efficiency between material at the outside of the casting and that at the interior. The metal, when poured, seemingly is wholly free of impurities.

25—*This is not correct, as all high speed steels as cast have the same appearance no matter by what method they are made. The cast method high speed steel is not at all fibrous, but granular, and is one of the differences between cast and forged high speed steels.*

Castings of high speed steel for cutting tools are annealed, rough ground to size after being bored for the arbor, heat treated, hardened, etc., according to standard practice. A further advantage of the process is that uniformity of analysis is obtained and a high durability, toughness and longevity. These ordinary high speed steels will sometimes show surface checks[26] if ground at too high a temperature, but steel made by this process does not show such effect even at red heat caused by grinding. Considerable loss occurs in heat treating forged steels due to cracks caused by strains which do not occur with this steel.

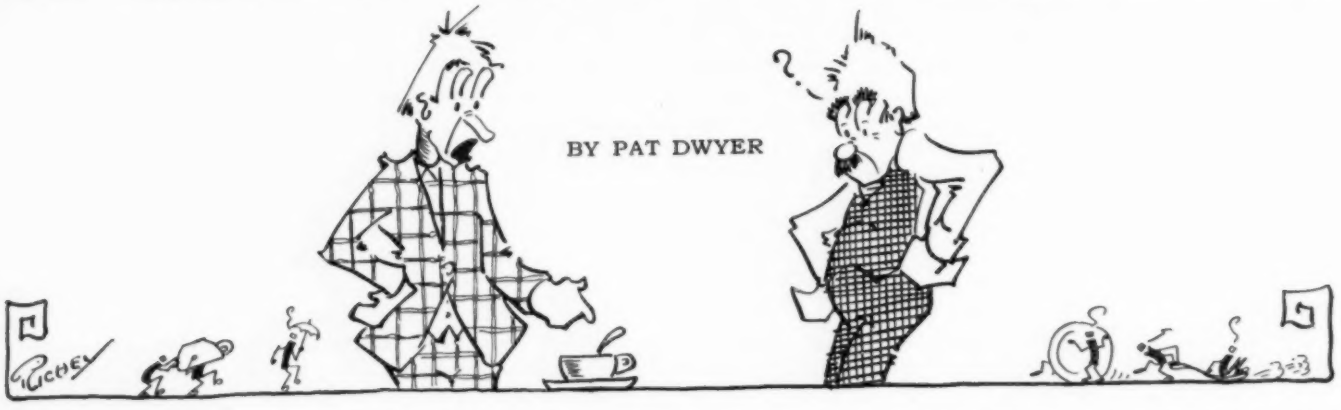
26—*With the same heat treatment, cast steel cutters will show greater tendency to check.*

Issue Corrosion Report

The American Society for Steel Treating, Cleveland, has issued a reprint of the paper on corrosion in mine waters, presented before the Pittsburgh chapter of the society by Robert J. Anderson and George M. Enos, both of the U. S. bureau of mines, Pittsburgh station. This paper discusses the problem of corrosion in a general way, especially as applied to the corrosion of metals and alloys in mine waters.

Controlling interest in the Phenix Brass Foundry, Phenix, R. I., formerly held by H. J. Finnigan, president, has been bought by Messrs. James and Morgan.

Bill Makes the Cup, Saucer and Spoon Mold



BY PAT DWYER

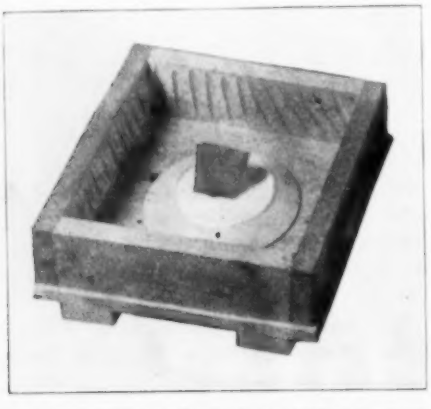
EVERY molder at one time or another in his career has heard of that peculiar casting in which an ordinary tea cup, a saucer and a spoon are cast in one piece, with the cup sitting in the saucer and with the spoon standing in the cup. The tradition is as familiar to machinery molders as it is to those engaged in the stove plate and hollow ware branches of the trade, but as naturally might be expected more actual castings have been made by men engaged in the stove plate and hollow ware shops. For one thing, the sand in those shops is adapted to the production of thin intricate castings and the men are more accustomed to its delicate manipulation. The old time all around molder usually had opportunity to turn his hand to all branches of the trade, but in recent years with increased production and specialization a more or less well defined line of demarcation has been established and a man usually follows one line or the other.

I was reminded the other day of the old tradition when my friend Art Congdon up in Port Arthur, Ontario, sent a remarkably fine specimen to the office. In a letter which accompanied the work of art, he stated that on a recent trial trip of a steamer built by his company the guests were served tea during the afternoon. The general manager was quite pleased with the performance of the boat and complimented our hero on the appearance of the engines. Then as a contrast to these huge pieces of machinery, he held up his tea cup and asked Art if he could cast one in iron. He was told that not only was it possible to cast a cup, but that a cup, saucer and spoon could be cast in one piece. The statement, of course, was received with mild incredulity. Since my veteran friend is a man who believes that deeds speak louder than words he immediately registered a mighty if silent vow that on the following day he would show them who was who and what was what.

In the morning he smuggled the necessary patterns down to the foundry, selected a quiet corner, moistened his hands in orthodox manner, pushed the old hard hat back on his head and made two molds. He did not give any data on the actual or elapsed time, but we assume he broke no speed records. In fact he supplied no operating data of any kind. Brief, and to the point, that's Art. Simply stated that he made two castings. He laid one on the manager's desk in silent but eloquent support of his statement on the preceding day and sent the second casting to THE FOUNDRY. As an after thought, in the shape of a postscript he suggested that probably Bill was familiar with the methods practiced in making castings of this character. I showed the casting one day to Bill and asked him if he ever had made one like it. He examined it critically and admiringly with the true and artistic eye of the real craftsman that appreciated all the fine points.

"That's a real job," said he. "I have not seen Art since we worked together in Hancock, Mich., many years ago. He was a handy lad in those days and I am glad to see that when the occasion arises he still can play a skilled and highly artistic solo in the foundry orchestra.

"Did I ever make one?" he continued. "I wish I had enough beer to fill all the cups I made or tried to make while I was serving my time. I made them at noon. I made them on Saturday afternoon. I made them at night after the wind went on and only a mortal dread of spoiling my only suit and the probability of being shot by the watchman or chewed alive by the watchman's dog, prevented me from trying to make one on Sun-



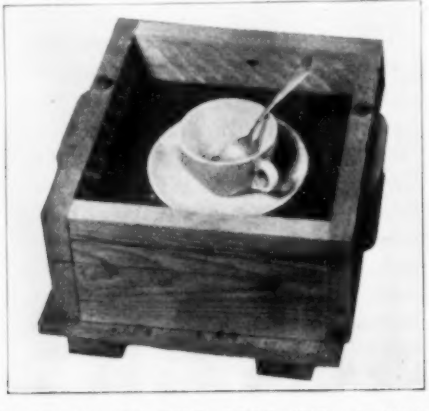


FIG. 1—SAUCER AND WEDGE GATE IN PLACE IN THE COPE FIG. 2—COPE ROLLED OVER, CUP AND SPOON IN PLACE IN THE CHEEK FIG. 3—PARTING MADE ON CHEEK READY FOR THE DRAG

day. Some dropped, some flopped, some ran out and others simply were wasters. In the glow of pride I experienced when finally I succeeded in making a good one I wouldn't have called Queen Victoria my aunt. She was still perched on the throne in those days, hence the allusion.

"I filed the casting and polished it and examined it lovingly a hundred times a day and for the first time in my life realized that the story of the Golden Calf probably was true. I experienced a lively feeling of regret because I had not the power to roll the centuries back and show these misguided people something really worthy of their attention.

"With the reckless abandon which char-

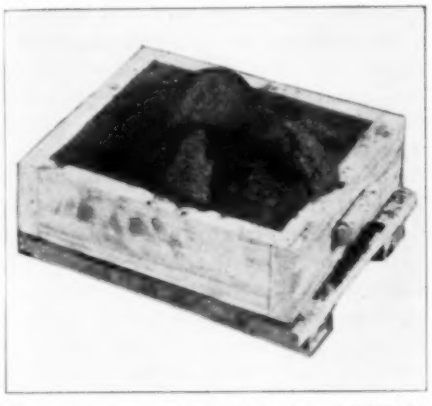


FIG. 4—THE DRAG AS IT APPEARS AFTER THE COPE, CHEEK AND PATTERNS HAVE BEEN REMOVED

acterizes young men at a certain age I presented the treasure to the young lady under whose charms I was for the time being a willing and abject slave. Old Monte Cristo rising at the end of Act II in his profusion of hair and whiskers and proclaiming to all and sundry that the world was his, had nothing on me at the moment of presentation. The young lady's speech of acceptance made me realize vividly how the same unfortunate hero felt at the close of Act I when he found himself incarcerated in the vile dungeon deep in the bowels of the Chateau D'If.

" 'It looks kinda nice,' said she, 'but vulgar. Why didn't you make the spoon separate so that it might be laid properly in the saucer?' "

"The love of a man for a maid is a wonderful thing—I have loved dozens—singly and in groups—but there is a limit and my affection for that young lady died right there. Kinda cute, but vulgar quoth she. Bah!

"However my disease was not fatal. I got myself another girl and she—."

"Oh! For heaven's sake forget it." I said. "I am not interested in your silly youthful philandering. I asked you a plain, civil question, to wit: If you ever had made one of these castings. If you want to tell me how you made it, go ahead, otherwise good night!"

"Well," said Bill, "I'll tell you. It is a rather difficult job to describe especially in terms within your limited comprehension. I'll tell you what I'll do. I'll make one at the shop tomorrow and take a series of pictures to illustrate the various steps. I'll bring the prints over in a few days and between the pictures and the description you probably will gain a fairly accurate idea of the method."

He brought the pictures over to the house last night and furnished the following information. He also borrowed a cup, saucer and spoon from the lady of the house and with a horny forefinger indicated where the various partings were made.

"On account of the thin metal section it is absolutely essential that the flask pins fit closely and accurately in the guides. The mold is made in a good grade of fine sand similar to that usually employed for brass or stove plate. It is possible to make the mold in a two-part flask by utilizing the bottom board for a third part, but a regular three-part flask is more convenient. I had a special little flask made in the pattern shop for the purpose. Fine sand is necessary to produce a smooth surface on the casting, to obviate parting line marks and also to furnish the required strength to the three drawbacks so that they may be handled with comparative safety. Even under the most favorable conditions, a light, deft touch is required for this latter feature, a touch that only is acquired after considerable practice.

"One of these drawbacks is between the back of the spoon and the inside surface of the cup. The other is in two parts on the outside of the cup and is designed to facilitate the removal of the cup handle from the mold. The sand in the mold is rammed to a fair degree of density, but not hard. This is a rather difficult point of information to convey to a person who has had no actual experience in ramming sand. I might say that the sand is rammed in the manner practiced in hollow ware shops. Perhaps a better definition would be to say that the sand is rammed just sufficiently hard to hold its shape during the manipulation of the mold in the formative stages and afterward while the mold is filling with iron. The various successive steps in the formation of the mold are shown in the accompanying illustrations. They may not be quite as complete and illuminating as a slow motion film, but I think they cover the process in a satisfactory manner. Like our friend Falstaff describing a certain mythical wound, 'It is not as wide as a barn door or as deep as a well, but it will serve.'

"In foundry parlance the mold is rolled over twice. This is not strictly accurate since only one part of the mold is rolled twice. The cope is rammed first and rolled over, the cheek and drag are rammed on top of the cope and then the three parts are rolled over together, thus bringing the cope back to its proper position on top.

"The saucer is placed concave side down in the center of the rollover board as shown in Fig. 1. The cope part of the flask then is set on and

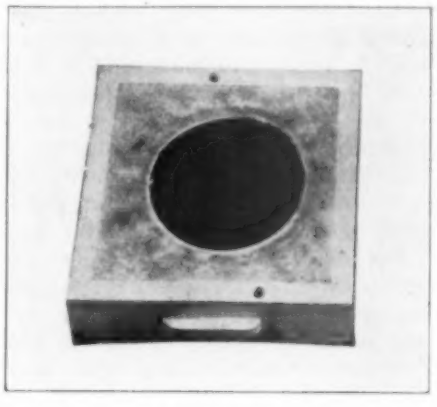


FIG. 5—SAUCER MOLD IS IN THE COPE

the gate pin is adjusted upright on the center of the saucer. The style of gate is optional. It may be either round, ½ inch in diameter, or the flat wedge gate about 2 inches wide usually employed on hollow ware and stove plate. With proper precautions one will distribute the iron and afterward break off as cleanly as the other. However, under ordinary working conditions, the round gate has a tendency either to break into the casting or leave a small stump. Since the flat gate rarely presents either of these objectionable features, it is preferred by molders working on light work. If it is not adjusted properly it will create just as much trouble as the round gate and in the same manner, but that is true of any step in the process that is handled carelessly or without sufficient skill and knowledge.

"Sand is sieved over the pattern and banked up around the gate to hold it upright in place. The cope is filled with sand, rammed, struck off flush with the upper edge, fitted with a board and rolled over with the gate stick still in place. The sand joint is brushed clean and sprinkled with parting sand. The

cup and spoon are placed in position on the saucer followed by the cheek part of the flask as shown in Fig 2. Sieved sand is tucked with the fingers into the acute angle between the rounded lower part of the outside of the cup and the saucer. The remainder of the space between the outside of the cup and the flask then is rammed full of sand and struck off flush with the upper edge of the flask. If the cup is not as deep as the flask, a parting will be made from the edge of the flask down to the rim of the cup and, of course, if the cup is deeper than the flask the parting line will run down from the rim of the cup to the edge of the flask.

"After the general parting is made in the form of a flat surface, two points are treated in a special manner. A small mound of sand is built with the fingers on the under side of the spoon handle, and a hollow is scooped around the handle of the cup. This step is shown in Fig. 3.

"One or two nails are driven in the small mound of sand under the handle to reinforce it and insure that it will *lift* at a later stage of the proceeding. The surface of the hollow around the handle is covered with wet parting sand or any other parting medium. One-half is packed full of sand and a vertical parting is made along the center line of the handle both inside and outside. This surface is covered with wet parting sand and then the remaining half of the hollow is packed full of sand. The upper surface is slicked flush with the rim of the cup and the face of the flat parting made at the time the cheek was filled with sand.

"At this stage many molders provide some means for handling the two half drawbacks later. Pieces of cardboard or tin usually are employed. With the exception of one straight line where the edge of the tin coincides with the straight parting line, the remaining outline of the tin need not conform to the shape of the base of the drawback. So long as it covers the entire surface, that is all that is required. Of course a due regard for the proprieties and the pride any craftsman takes in neat appearances will prevent him from employing a great unwieldly piece of tin for the purpose outlined. Each piece of tin is smeared lightly with paste on the contact side and pressed down gently on its respective half of the drawback. However, I dispensed with this precaution and found that I could slide the drawbacks away easily with a double ender.

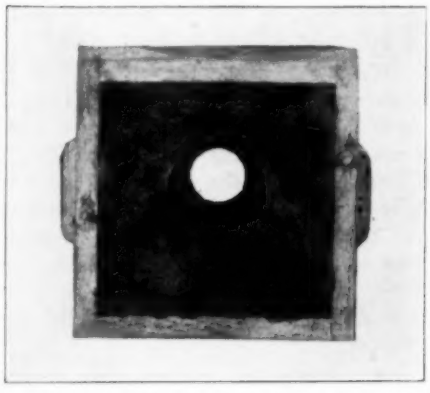


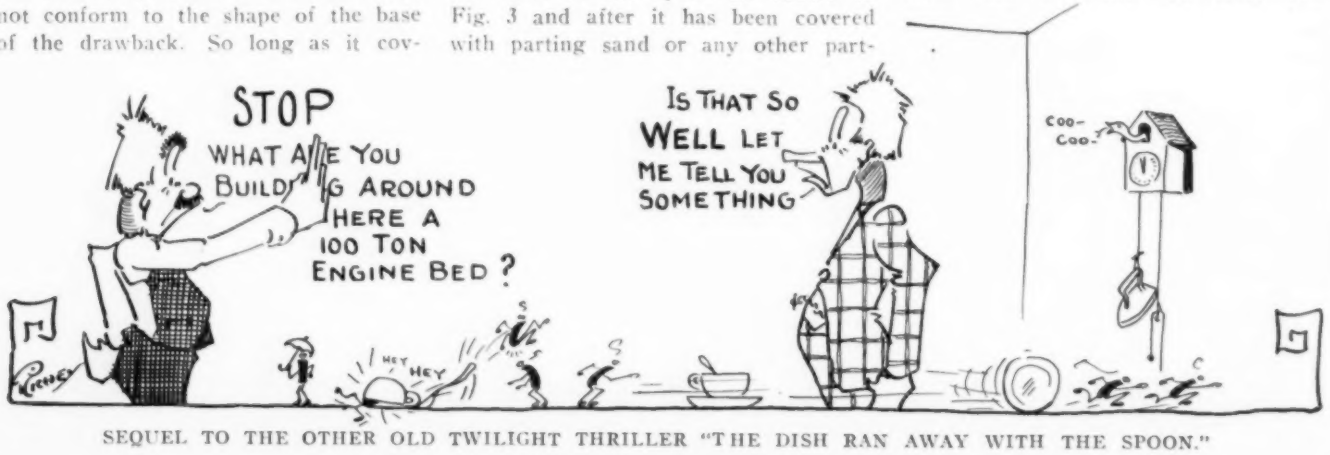
FIG. 6—DRAG SIDE OF CHEEK MOLD

"We now come to one of the most delicate stages in the performance and that is in arranging the sand in the inside of the cup so that the spoon may be withdrawn at the proper time. Sand is packed between the back of the spoon and the inside surface of the cup and usually it is advisable to reinforce this delicate body of sand with a few pieces of wire or long *finishing* nails from the pattern shop. This little bit of sand is responsible for nearly all the lost castings. It is apt to sag after the spoon pattern has been removed and thus shut off the cavity destined for the reception of the metal. It is advisable to make it entirely of new sand since new sand has a stronger bond than sand that previously has been used.

"A flared parting is made around the bowl of the spoon as shown in Fig. 3 and after it has been covered with parting sand or any other parting medium, a handful of sieved sand is placed in the bottom of the cup. Four spikes are placed upright in the sand to serve as lifters in supporting the sand. The drag is set on and rammed full of sand. Certain varieties of sand requiring no venting, but usually it is advisable to use a wire on the drag. A few vent holes down into the inside of the cup may not be necessary but certainly they will do no harm.

"The drag with the suspended body of sand forming the inside of the cup is lifted off and set on the bench. The spoon then is removed. A small opening is cut through the sand remaining in the cup commencing at the point where the point of the spoon comes into contact with the cup and extending back approximately ¾ inch. This opening is to provide an entrance for the metal. Otherwise all the metal to form the spoon would have to enter at the lower opening where the spoon touches the rim of the cup. The parting surface is smeared lightly with paste and the drag is returned to place. The purpose of the paste is to anchor the small body of sand to the larger body forming the interior of the cup and to prevent it from *floating* when the mold is filled with metal.

"The entire mold then is rolled over which brings the cope back into its proper position on top. The mold now is complete and it only remains to take it apart, remove the cup and saucer, reassemble the mold and pour it. The cope with the gate still in place is lifted off and placed on edge on the bench. The molder runs a small tool, usually a small double ender or a *Yankee slicker* along both sides of the gate where it comes in contact with the pattern. The heel of a lifter or the point of a trowel may be employed for the purpose if neither of the other tools are available, but practically every molder has one or both of the first mentioned tools and they are the most con-



SEQUEL TO THE OTHER OLD TWILIGHT THRILLER "THE DISH RAN AWAY WITH THE SPOON."

venient. The purpose of the slicking is to render the edges of the gate firm and to prevent the sand from *washing* while the metal is passing into the mold. After the sand has been slicked and if the occasion seems to warrant, swabbed lightly, the wood gate is removed.

"The saucer pattern is lifted away from the cheek. This may be accomplished in any one of several ways and the method is optional. It can not be removed in the usual manner by inserting a screw or spike. In the somewhat remote event that the molder is blessed with long finger nails he can insert the points under the edge at opposite points and lift the saucer in that manner. He can slip the point of a finishing trowel or double ender, or even the heel of a small lifter, under one edge and tip the pattern high enough to grasp it with his fingers. Probably the neatest method is to moisten a lump of clay and press it against the bottom of the saucer, then when the clay is lifted the saucer will come with it. The feather edge around the base of the handle drawbacks is cut away, partly because it would crumble during removal, but principally to afford an opportunity to cut a light mark in the drag sand to serve as a guide in returning them to place after the pattern is removed. Some molders, as stated previously, favor the use of a small piece of tin or cardboard for handling the drawback. The pieces are placed on the base of the drawback, one piece on each half before the drag is rammed, but by exercising proper care they are not necessary. The point of a thin double ender is inserted at the back of the drawback in the center and one-half gently is pushed to one side. It is only necessary to push it about one-half inch. The second half then is pushed away from the other side. The handle then is exposed and the cup may be removed. It is tapped gently during the first part of the lift to prevent the small body of sand covering the spoon on the inside from adhering to it.

"After the cup has been removed the two small drawbacks forming the handle are moved forward into position and the feather edge that was cut away is made up again. The cheek is replaced, followed by the cope and after a weight has been placed on top of the mold it is ready for the metal. Needless to say only the hottest kind of iron is fit to pour the casting. It must be poured gently, otherwise it will rise in the mold violently and lift the overhanging circle of sand in the cheek.

"In the interest of smoothness and accuracy it might be considered desirable to attach the two handle drawbacks to the cheek after the pattern has been removed, instead of sliding them forward to their approximately correct position on the drag. The advantage of this method is that the joint may be slicked over and in that way the face of the casting will present a perfectly smooth appearance. The objection to the method is that it is a hazardous little undertaking and may result in loosening some or all of the sand in the cheek."

"I have only one comment to make," I said, "and that is you have taken as much time and used up as many words to describe the making of a toy as many a man has employed in describing the making of a 100-ton engine bed." "Is that so?" said Bill. "Well let me tell you something young feller. I have known many men who were perfectly at home on 100-ton jobs who could not earn cigaret money if they were switched without warning for half a day on the cup-saucer-and-spoon and paid on a piece rate basis. Touching on the feature of using too many words, thank heaven I have not yet arrived at the stage exemplified by the meek little man who was asked by one of those nosey birds who always are asking questions, if he ever had words with his wife. 'Well,' he ventured, cautiously looking around, 'I have lots of words but never get a chance to use them.' " "No," I grudgingly had to admit. "Whatever faults and failings you may have, you certainly never could qualify as a member in good standing in that patient and long suffering class usually and familiarly referred to as the silent minority. I have not the slightest difficulty in realizing that as a result of a peculiar twist of mind, you find yourself in the minority often enough, but I do not think even the most hardened character could so far forget himself as to claim that you ever are silent except when you are asleep.

FAKED FOUNDRY FACTS

A BUILDING RING

Ridenour, Seaver & Kendig, Chamber of Commerce building, Pittsburgh, representative of the Industrial Works, Bay City, Mich., in connection with the sale of cranes in this territory, have taken over the hoisting equipment line manufactured by the Clyde Iron Works, Duluth, Minn., including derricks, hoists, etc., for western Pennsylvania.

How and Why in Brass Founding

By Charles Vickers

Core Mixtures for Brass Wheel Cores

We require a formula for a mixture suitable for trolley wheel cores and cores for armature bearings weighing from 15 to 45 pounds. We use a mixture of white beach sand and fine molding sand bonded with proprietary binders both oil and dextrin. We bake the cores in a gas-fired oven.

The following mixture makes a good small core and is suitable for the purpose outlined: Dry white sharp sand, 14 pounds; dry new molding sand, 10 pounds; linseed oil or substitute, 12 ounces by weight. Mix the sands thoroughly, damp with water until a little dryer than will be used and rub in the oil. Some coremakers prefer to determine by experiment just how much water the sands will require, then in future batches to boil the water and mix with the oil, and use the mixed oil and water to temper the sands. This method is supposed to save oil. A good rosin sand core is made as follows: Mix 30 pounds sharp sand and 10 pounds old molding sand with 2 pounds of pulverized rosin, then dampen with water. Bake the cores at a temperature that will liquify the rosin, and remove them from the oven when they smoke strongly.

Another core mixture is made of 6 parts of new molding sand, 4 parts old molding sand, 15 parts sharp sand and 1 part dextrin. In drying cores two things particularly are required, heat and a current of air. With oil-bonded cores the oil has to be oxidized and the best results will be obtained by changing the air in the oven at least once during the drying operation.

Formula for Alloys To Resist Pressure

We desire to obtain a mixture for an alloy which will sustain a heavy pressure. We now prepare a mixture as follows: Using an alloy of 85 per cent copper, 5 per cent tin, 5 per cent lead, and 5 per cent zinc; we add 4 ounces of phosphor copper to each hundred pounds. We find that all of the castings leak.

If the pressure is high it will be necessary to use an alloy containing considerably more tin than ounce metal which has never been considered a pressure-resisting alloy. It will, of course, resist moderate pressures, but why for such pressures, use so expensive an alloy when cheaper alloys will do the work just as well?

The two following alloys are used considerably as pressure-resisting metals. As the pressures the castings are to resist are not given in the query, and we must grope blindly. First try the following alloy which is the cheaper. Copper 82 per cent, tin 7.5 per cent, zinc 4.75 per cent, and lead 5.75 per cent. Should this alloy fail, then the following must be used: Copper 83 per cent, tin 11.5 per cent, zinc 4 per cent, lead 1.5 per cent.

The latter alloy is rather brittle but the grain is made dense by the content of tin. S. D. Sleeth of the Westinghouse Air Brake Co., should be credited with these alloys.

Handling the Fifty-Fifty Copper-Lead Alloy

Kindly tell us the method for making alloys of 50 per cent copper and 50 per cent lead.

To make an admixture of half lead and half copper; first melt the copper under charcoal, then add the lead and get it hot and allow it to remain in the furnace for a few minutes. It is not necessary to pour the castings with metal as hot as it comes from the furnaces. Usually it is permitted to cool but it should not be poured at too low a temperature.

Some makers of this mixture put in a piece of roll sulphur, but if you can succeed in making a casting, the lower half of which is not almost pure lead, instead of 50-50 mixture, and refrain from the use of sulphur, it will be advisable to dispense with the use of sulphur. It may be remarked that it is not difficult to do this.

The most important thing about this half and half mixture is to be watchful and not get caught selling the castings at too low a price. Do not allow the customer to do the figuring, as all he thinks about is the low price of the lead; whereas the alloy in castings will cost as much as 88-10-2, and frequently considerably more; in fact, legions of brass foundrymen have burned their fingers on this simple alloy in more ways than one.

Getting Fine Finish on Brass Castings

We are making brass castings weighing from 100 to 250 pounds each which must have a nice exterior finish, and we would like a good mixture of a facing sand. We prefer one that is easily and quickly prepared, and which is dried easily with a torch.

Use an open grade of molding sand no finer than an Albany No. 3 grade, then drying will not be necessary for castings of the weight given. After pouring allow the castings to cool in the sand until they cease to be red, then shake out and scrub them with a spade and with coarse, heavy files, and they will have a satisfactory finish.

Do not attempt to get a smooth exterior by using a molding sand of fine grade, otherwise the machinist will discover an interesting crop of holes when he cuts the skin away. If the metal is heavily phosphorized and the proper pouring temperature cannot be judged, use a dry sand facing as follows:

No. 3 molding sand (new) 1 part.
No. 3 molding sand (used) 2 parts.

Add one part of a good grade of flour to every 20 parts of sand, or bond with dextrin in the same proportions as for cores. Paint the molds with plumbago wash, using a camel's hair brush, then run them into the oven and dry properly, as the casting will be no better than the mold.

The facing given can be used for the molds for skin drying, but blacking must not be painted on wet. It can be brushed on dry, then polished. The facings should be mixed in a sand mixer to do this properly and easily. Prepare these facings the night before they are to be used and pat the sand down with the flat of the shovel, then sprinkle and leave until the next day. Do not expect to do the work too easily or too quickly, or the result will be disastrous.

Surface Defects Show in Manganese Bronze

We are making manganese bronze propellers but find difficulty getting a smooth surface on the blades which come drossy and fail to polish without flaws. Our

method is to pour them on the hub using large sprues to prevent shrinkage, and we take off vents from the blades to carry away the gases from the mold. While we have never lost a casting using this method we are not satisfied with the surface obtained, and desire to know if by gating the castings differently better results could be obtained? Also we desire to make a tougher manganese bronze and want to know if adding iron to aluminum bronze would give us what we want?

When manganese bronze is drop-gated, better results are obtained. That is, the dross is controlled when a basin is placed over the sprue and the mouth of the latter is plugged by an iron handled stopper which is lifted after the basin has been filled with bronze. It is necessary to keep the basin filled with metal until the mold is full. This method of gating is illustrated in the May 1, 1923 issue of THE FOUNDRY, page 364.

While castings are made of manganese bronze by drop-gating them, as it is sometimes necessary to do so, the best way of running this alloy is to flow it into the mold at the lowest point in order that it may rise gradually, and thus avoid all agitation. It is the agitation of the metal that produces dross, although less is produced in the absence of air as in the method suggested above. To run a propeller from the lowest point the gates would require to be placed on the blades, with a heavy riser on the hub, and propellers of two, three and four blades are so cast, both small and up to several feet in diameter. On a heavy hub it is customary to *pump* the riser and fill up with fresh metal. If this method of gating is used there should be no difficulty getting clean castings.

The addition of iron strengthens aluminum bronze, but the alloy would be difficult to run into propellers, and only those with special knowledge of the alloy would be successful.

Scrap Copper Introduces Iron in Mixture

We desire to learn why copper is hard to cut when the mixture consists of copper 65 per cent; red copper 37 per cent, lead 1.5 per cent, and tin 1.5 per cent. The metal appears to be full of hard spots the size of pin heads and which look like little balls.

The reason the copper is hard to cut is that the little hard spots are iron. Iron balls up in this way in copper because the iron contains carbon; in fact, is steel, or it may be cast iron, depending upon the amount of carbon present. The secret of the matter is that iron has a strong affinity for carbon when combined while it is neutral as far as copper is concerned, for copper is not attracted by carbon. So the iron and carbon being united will have nothing to do with the copper, and iron and carbon, as is well known form a hard substance.

The remedy is to use copper that contains no iron. You must be using 65 per cent of scrap copper and that is how the iron is introduced. The *red* copper, we take it, is ingot. To get castings that will machine easily, use all red copper, that is ingot. If the castings are priced so low that scrap must be used, the price is too low. Charge the cost of new copper, add to it about 15 cents a pound for the cost of making the castings, and allow a profit. That price will be low enough.

Alloying Aluminum

We have orders for aluminum alloy castings of a special formula containing manganese and magnesium, and we wish your advice regarding the most practical manner of adding these metals, so the desired results can be obtained, both as to appearance of the castings and their strength. We also would like to know how much magnesium to add to aluminum to obtain a tensile strength of 30,000 pounds per square inch, and what elongation could be expected with this tensile strength?

The most practical way of adding manganese to aluminum is in the form of an alloy of the two metals, which contains approximately 25 per cent of manganese. This alloy is commercially obtainable and firms handling it are noted in the advertising pages of THE FOUNDRY. Magnesium is added to aluminum in the metalic form, in the same manner as adding a piece of zinc, for instance. The solemn ceremony of tying it to an iron bar "to plung it to the bottom," etc., is usually dispensed with by practical men, either when alloying it to copper or aluminum.

Magnalium is an aluminum-magnesium alloy containing about 5 per cent magnesium. However, its tensile strength is not 30,000 pounds per square inch, but around 22,000 pounds with 4 per cent elongation. It must be poured as cool as possible. An alloy of aluminum 92.50 per cent; magnesium 1.50 per cent; nickel 2 per cent; copper 4 per cent, is credited with a tensile strength of 30,000 pounds per square inch and an elongation of 2 per cent.

If a specification of 30,000 pounds per square inch has to be met, we would suggest the following alloy: Aluminum, 87.50 per cent; iron, 1.50 per cent; copper, 3 per cent; zinc, 8 per cent, which has 33,000 pounds per square inch tensile strength, but about the same elongation as No. 12 alloy. If it is necessary to use magnesium, replace the zinc with 2 per cent magnesium. The manganese-aluminum alloys will not have 30,000 pounds per square inch tensile strength, but the elongation is high.

Cast Iron Around Bronze

We have a number of phosphor bronze bushings 13 inches long, 3 inches in diameter, with 5/8-inch metal thickness, which we want to use as bushings for the hub of a pulley. To get an immovable fit it is necessary to cast the iron around the bushings. We find the bronze melts and sags an inch or more and the metal soaks into the core used to plug the hole in the bushing. The pulley casting weighs 250 pounds and has a web center with a heavy hub. Can you suggest any way of casting the iron around the bronze?

If the bronze bushing can be cooled so it will not melt, the iron can be cast around it. This could be done by water cooling. If a wrought iron pipe is fitted into the hole in the bushing so as to contact well with the same throughout its length and the pipe connections are made to extend outside the flask, water could be run through until the iron is cooled. Cast iron cannon weighing several hundred thousand pounds were at one time cast with cores cooled in this manner. It would be necessary to have tight strong joints in the pipe line, as a leakage of water in the mold would be disastrous.

When the hole in the core is filled with molding sand and the entire bushing is covered with sand, it is insulated against escape of heat. Therefore, as the bronze melts under the temperature of the molten iron, it is inevitable the bushing will melt when the iron is poured in unless precautions are taken to prevent it. The outside of the bushing should be roughened so the iron will take hold, and even if melted will be held firmly.

A method that carries no element of danger is to cool the bronze bushing by the use of graphitic carbon. This carbon is soft and cuts freely and can be obtained in round rods of varying sizes. Should a piece of the size to fit the hole in the bushing be selected, it could be passed through and be allowed to stick up through the cope. This carbon rod will conduct the heat away from the bronze rapidly enough to prevent its melting, which is all that is required. A rod of copper might possibly answer, but it would have to be coated to prevent it sticking in the bushing.

Progress in Gray Iron Industry

Melt with Two Cupolas Into Common Hearth—New Electric Furnace Has Two Melting Chambers with but One Top—Causes of Defects Pointed Out and Improvement of the Metal Shown

BY ENRIQUE TOUCEDA

WHILE many of the modern gray iron foundries are replete with both overhead and floor labor saving devices, are well designed for day artificial illumination, well ventilated and sanitary, and have splendid equipment, the one feature in the case of many is lack of sufficient charging room floor space. I am speaking of this matter because it has appeared to me that this important part of the foundry has received less attention than any other. In one of the best foundries that I have seen, the charging room is comfortable and clean; well ventilated, and so large that a month's supply of coke can be and is stored at one end.

Use Double Furnace

Twin cupolas are used in this foundry. These cupolas are 4½ feet apart, and built integral with them and between them is a rectangular hearth. This assemblage is called a melting unit, of which there are two. Both cupolas in the unit are operated at the same time, and under the conditions stated the molten metal is obviously at the same level in the entire system. The cupolas both have two charging doors opposite each other, one for the coke and the other for the pig iron. The pig iron is not raised to the charging room floor by an elevator, but is placed in a side-dump car attached to a cable and is discharged directly into the cupola upon its arrival opposite the charging door. The door sill is protected by an inclined wearing and guiding plate. The mixtures for the day are put up under cover and near the point where the incline starts. In this manner the pig, sprue and scrap can be placed on the charging cars and run up to the charging floor with less labor and more convenience than is possible where an elevator is used, and where the metal for the charge is spread over the charging floor.

At another foundry one of the things that appealed to me was the manner of rigging up to rough clean large castings as they came from the foundry floors. For this purpose a space about 20 x 20 feet square is enclosed by a wooden fence about 8 feet high and covered with galvanized sheet steel. On one of the sides are doors of such size as to permit the introduction of the casting that is to be cleaned. Two hose nozzles protrude through appropriate openings on one side, about 3 feet apart, the nozzles being mounted on flexible connections that admit of their being pointed in any direction. Small windows above the nozzles enable the operator to observe the operation from his position outside of the enclosure. Both on the inside and outside of the flexible joint a piece of loose canvas is tied around the nozzle and the edges are tacked to the fence. A stream of water at about 200 pounds per square inch pressure is played on the castings which are cleaned at a low labor cost.

New Type Furnace

The use of the electric furnace in the gray iron foundry is receiving increased recognition, particularly in duplexing. A new arrangement of the electric furnace that has come to the attention of the speaker is built in Pittsburgh. Two 1½ to 3-ton furnaces are mounted upon a revolving platform by which means the same transformer and set of electrodes can be used for each furnace alternately. If a cold charge is used, the procedure is to charge both furnaces and when the material is ready to tap from the active one the electrodes are raised, the table revolved and the other furnace placed in position under the electrodes. The melting in the second furnace then is started coincident with the tapping of the first furnace. Thus, no time is lost between melting periods. Each furnace can be operated independently, while the other is undergoing repairs. By the continuous operation of single substation a high load factor, lower power cost, and a saving in electrode consumption are said to be secured. It is the speaker's thought that it might prove advantageous to make the furnace perform the dual function of furnace and transfer ladle; that is, three or four small furnaces could be mounted on trucks on a track that would pass under the electrodes and down to the molding floors. These when ready to be tapped could be run down opposite the floor where the molten metal is intended to be used.

One of the most common defects found in gray iron castings is the blow hole. Of all casting troubles this is the one of which the foreman always seems to know the cause and when he believes that damp sand is not the cause he is positive it is due to inefficient venting. In many instances that have come to my attention I have been convinced that the blowholes shown me were occasioned by dull metal, and not at all by either damp sand or lack of venting. While this is not presented as anything new mention is being made of this fact because the foundryman invariably seems loath to consider this as a possible cause of trouble, particularly if the metal from the cupola spout has been very hot. He fails to realize that it is possible to obtain sizzling hot metal from the spout, and at the same time, due to some delay, a particular mold, or perhaps all the molds on a distant floor may have been poured with dull iron.

Another cause, and one that may be new to some foundrymen, has been found to be due to the use of core or molding sand that is contaminated with particles of sea shells, These are composed of carbonate of lime, which if heated to about 1470 degrees Fahr. will liberate carbon dioxide gas. Moisture, on the contrary, is converted into steam at the comparatively low temperature of 212 degrees Now, when either extremely hot or dull molten metal strikes damp sand, steam immediately is generated. This will excape readily from the mold if the sand is open and the venting good. However, whether the iron is hot or cold, some steam will be caught in the metal as it passes through the voids in the mold. In case the iron is extremely hot and fluid, the expansive force of the steam is sufficiently strong to enable it to force itself out of the still molten metal before the iron starts to solidify

Abstract of a paper delivered at the meeting of the National Founders' association, held in New York, Nov. 21 and 22.

CONTRACTION OF LIGHT ALUMINUM ALLOYS

(*Continued from Data Sheet No.* 506)

Effect of Tin—Tin reduces the contraction of aluminum, and aluminum-copper alloys; its effect on aluminum, however, is not so marked as that of copper. Some comparative figures are given in the accompanying table.

Linear contraction of some tin-containing aluminum alloys; bars of different cross sections poured at high and low temperatures in sand molds.

Alloy Number	Nominal Composition	Linear Contraction, per cent, for bars poured at 700 degrees Cent. 0.5-inch square bars	1.0-inch square bars	0.5 by 1.0 inch bars	Linear Contraction, per cent, for bars poured at 900 degrees Cent. 0.5-inch square bars	1.0-inch square bars
1	100 Al	1.68	1.68	1.64	1.54	1.60
13	92:8 Al-Sn	1.49	1.53	1.50	1.31	1.48
3	92:8 Al-Cu	1.42	1.43	1.37	1.33	1.40
27	90:8:2 Al-Cu-Sn	1.39	1.42	1.38	1.25	1.38
28	88:8:4 Al-Cu-Sn	1.31	1.33	1.35	1.25	1.35
29	85:5:10 Al-Cu-Sn	1.30	1.36	1.28	1.27	1.32

Effect of Zinc—Zinc lowers the contraction of aluminum, but its effect is not so pronounced as that of copper. However, as has been indicated previously, some alloys containing up to 33 per cent zinc are suitable for certain castings, and commercial aluminum-zinc alloys may be employed that have less contraction than commercial aluminum-copper alloys containing up to 14 per cent copper. The following table gives some comparative figures for the linear contraction of zinc-containing aluminum alloys.

(*Continued on Data Sheet No.* 508)

CONTRACTION OF LIGHT ALUMINUM ALLOYS

(*Continued from Data Sheet No.* 507)

Linear contraction of zinc-containing aluminum alloys; bars of different cross sections poured at high and low temperatures in sand molds

Alloy Number	Nominal Composition	Linear Contraction, per cent, for bars poured at 700 degrees Cent. 0.5-inch square bars	1.0-inch square bars	0.5 by 1.0 inch bars	Linear Contraction, per cent, for bars poured at 900 degrees Cent. 0.5-inch square bars	1.0-inch square bars
1	100 Al	1.68	1.68	1.64	1.54	1.60
14	90:10 Al-Zn	1.53	1.53	1.54	1.44	1.55
15	80:20 Al-Zn	1.42	1.39	1.38	1.33	1.43
16	67:33 Al-Zn	1.28	1.27	1.27	1.25	1.27
3	92:8 Al-Cu	1.42	1.43	1.37	1.33	1.40
30	90:2:8 Al-Cu-Zn	1.49	1.42	1.49	1.42	1.43
31	90:8:2 Al-Cu-Zn	1.37	1.43	1.33	1.25	1.46
32	85:3:12 Al-Cu-Zn	1.34	1.38	1.30	1.38	1.35
33	77:3:20 Al-Cu-Zn	1.35	1.30	1.33	1.33	1.25

Effect of Additions of 2 Per Cent of Various Metals on the Contraction of 92:8 *Aluminum-Copper Alloy*—The first of the two following tables shows the comparative linear contraction of four alloys of the 92:8 Al-X type, and the second table gives data for the comparative contraction on a number of alloys of the 90:8:2 Al-Cu-X type, which may be found useful for ready reference. When added to aluminum in the amount of 8 per cent, the metals are to be listed as follows in the order of their effect upon the contraction; (1) magnesium, (2) copper, (3) tin, and (4) nickel, where the first mentioned has the greatest effect in lowering the contraction. This refers to 0.5-inch square bars poured at 700 degrees Cent. Similarly, where 2 per cent of different metals is added as a substitute for aluminum in the 92:8 aluminum-copper alloy, giving rise to ternary alloys of the 90:8:2 Al-Cu-X type, the metals are to be listed as follows in the order of their effect upon the contraction; (1) magnesium, (2) silicon, (3) zinc, (4) tin, (5) nickel, (6) iron, and (7) manganese, where the first mentioned has the greatest effect in lowering the

(*Concluded on Data Sheet No.* 509)

THE FOUNDRY DATA SHEET, JAN. 1, 1924

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

THE GLOBE IRON-CRUSH & SHOT CO.

(FORMERLY THE GLOBE STEEL COMPANY)

GLOBE H. C. SHOT FOR SAWING AND RUBBING GRANITE, MARBLE, STONE, GLASS, TERRA COTTA, ETC. GLOBE CORE DRILL SHOT.

IRON ABRASIVE MANUFACTURERS

GLOBE IRON-CRUSH AND GLOBE H. C. SHOT THE IDEAL ABRASIVES FOR SAND BLASTING

MANSFIELD, OHIO, U. S. A.

May 28th, 1923.

The Foundry,
Penton Building,
Cleveland, Ohio.

Gentlemen:- Attention: Mr.J.D.Pease, Advertising Dept.

QUOTATIONS SUBJECT TO CHANGE WITHOUT NOTICE. ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, ACCIDENTS AND OTHER DELAYS BEYOND OUR CONTROL.

Replying to yours of the 23rd, we are pleased to advise we consider "The Foundry" one of the very best advertising mediums for our line of chilled steel shot and other abrasives.

We have had space, as you know, in every issue of Foundry for a number of years, and we have found that not only does it cover the foundry trade thoroughly in America, but also abroad. Results obtained have been very satisfactory, and we feel that "The Foundry" has played a big part in placing GLOBE HIGH CARBON CHILLED SHOT in the position it now holds in the foundry trade.

We can heartily recommend"The Foundry" to any companies having products to sell to the foundry industry of the world.

Yours very truly,

THE GLOBE IRON-CRUSH & SHOT CO.
(Formerly The Globe Steel Co)

By L. A. Cline

Secretary.

LAC:c

against the sand. If the metal is dull a thin shell of solid iron will form against the sand so quickly that bubbles of entrapped steam cannot force an exit, with the result that blowholes will be formed. This situation is much more serious when a carbonate is in the sand, because, as already indicated, carbon dioxide gas is not liberated from carbonate until their temperature has been raised to around 1470 degrees Fahr. This implies that no matter how hot the metal entered the mold it is considerably cooler at the instant this gas is liberated, and therefore the gas never has that opportunity to escape when entrapped that obtains in the case of steam. Consequently, the chances are that blowholes will be found in the castings when carbonates are present in the sand no matter how hot the metal is when poured These blowholes invariably will be found just under the skin. For obvious reasons it is equally important that all facings be free from carbonates of any kind.

It might be pertinent to make a few remarks concerning the progress that has been made in the quality of gray iron. We find that the introduction of steel into the mixture has resulted in the production of a stronger metal, the average ultimate strength of which may be placed at about 33,000 pounds per square inch. A special gray iron product that will average around 50,000 pounds per square inch ultimate strength, possessing a measurable ductility, and machineable at practical speed is now being produced at a foundry in the South. Of 10 tensile test bars of this product tested by the U. S. bureau of standards, the lowest ultimate strength was 45,300 and the highest 56,500 pounds per square inch. The elongation in the case of four of the bars was 1 per cent, while the average brinell number was 290.

That any specified gray iron product now can be made with a fair degree of uniformity by even those not equipped with a chemical laboratory must be acknowledged, as dependable blast furnace analyses accompany each car of pig iron shipped. Actually what may be stated is that uniformity of product can be assured; that great progress has been made in increasing the ultimate strength in the case of such castings as are not required to be machined; that this would not obtain in the case of castings that have to be machined to accommodate present day mass production; that through the use of ferroalloys or the straight additions of certain metals the possibility of making a product of high ultimate strength that will be easy to machine is remote; that in the absence of heat treatment, no one has been able to impart to the slightest degree any ductility to gray iron, except to the trivial extent found in the high strength castings to which reference has been made. When heat treatment is applied today it is for the purpose of increasing the machineability of small castings for the development of tortional or transverse ductility, and to remove internal strains.

Guards Core Car Wheels

Safety bumpers or rail scrapers which prevent truck wheels from running over workmen's feet on the track, are attached to all cars used on industrial tracks and also on the cranes in the foundries of the American Radiator Co. The device shown in the accompanying illustration is made up of a steel band 2 x ½-inch, bent in such a manner that it extends about 6 inches in front of the wheel, rides about 3 inches above the rail and is bolted at each end to the frame of the car. The National Safety council states that accidents in which workmen had their feet injured practically have been eliminated since the guards were installed.

THIS BUMPER PREVENTS THE WHEELS FROM RUNNING OVER OR OTHERWISE INJURING WORKMEN'S FEET

Will Sell Core Binder

William H. Albohn recently has joined the sales force of the Patent Cereals Co., Geneva, N. Y., in the capacity of salesman and demonstrator. The company is going extensively into the production of core binder and has secured the services of Mr. Albohn to introduce it to the foundry trade. He has had an extensive foundry experience and in recent years has held positions as foundry superintendent of the Snead & Co. Iron Works, Jersey City, N. J., and as foundry expert and salesman with the American Hominy Co., Indianapolis.

Filling Small Holes in Iron Castings

Question: What material is mixed with iron filings to form a cement for filling small holes in iron castings?

Answer: Many mixtures are available to the foundryman who wants to prepare his own material, but practically all are based on combinations of iron filings sal ammoniac and flowers of sulphur. One is made up of iron filings 60 parts, sal ammoniac 2 parts, sulphur 1 part. The mixture is moistened with water and stirred to a stiff paste. A second mixture easily prepared and applied, and greatly favored by foundrymen of a past generation is made by melting one part black pitch and one part rosin and then adding a sufficient quantity of iron filings to form a stiff mass. It is poured out on a flat plate and allowed to cool. The defective spot in the casting is heated, a piece of cement is placed over it and pressed into place with a hot iron. Of course this cement is not applicable to any part of a casting subjected to heat. In present day practice comparatively few foundrymen go to the trouble of preparing a filler. It may be procured in ready made form from the manufacturer or from foundry supply houses at a trifling cost.

Issue Magnesium Data

The American Magnesium Corp., Niagara Falls, N. Y., has issued a valuable handbook giving information and data relating to the use of magnesium and magnesium alloys. This book is of especial value as the data included have been verified in the works of the company from a wide research and on a production basis. Owing to the strong influence of minute quantities of impurities in the metal on its physical properties the methods of analyses are of great importance, and the methods given in the book will prove highly useful to the chemist who desires to analyze samples.

Mixtures Closely Controlled

A Test Block Cast with Two Different Thicknesses and Afterward Sawed Through the Center Longitudinally Indicates the Segregation of Iron Under Varying Conditions

AT THE suggestion and under the supervision of J. Carlton Ward Jr., general superintendent, a method has been developed for taking physical tests of the iron melted in the foundry of the Pratt & Whitney Co., Hartford, Conn., which it is claimed furnishes a more satisfactory index upon which to base the composition of the mixtures employed than the ordinary chemical analysis, or the information secured from the regular tensile and transverse tests. Chemical tests are taken to check pig iron shipments and on castings in which foreign scrap has figured prominently in the mixtures. These tests serve principally as a guide in keeping the sulphur and phosphorus within certain well defined limits. However, the physical test is considered the more important. By noting carefully from day to day the appearance of the machined surface of the test block, shown in Fig. 2, the foundry superintendent can control his mixtures to a point where he is reasonably sure his castings whether of heavy or light section, will conform to the requirements of the machine tool industry.

Represents Two Qualities

The grain of the iron in these castings is the most important consideration since it must represent two apparently contradictory qualities. It must be close and wear resistant and yet readily machineable. It has been found that chemical analysis alone practically is of no use in furnishing information by which the texture of the iron may be regulated. In some instances drillings taken from blocks with notoriously defective physical structure showed the same chemical analysis as drillings taken from blocks in which the grain of the iron was all that could be desired.

Usually two standard mixtures are employed, one known as hard iron and the other as soft iron. The hard mixture is poured into all large castings and also into others that present wear resisting surfaces such as cams, slides, gibs, etc. In thin sections this metal presents a cut surface that almost resembles steel. The silicon content is kept fairly high and no trouble is experienced in machining the metal. A careful study of the test blocks has disclosed that the grain of the metal is dependent almost totally on two principal factors. One is the percentage of steel in the cupola charge and the other is the silicon content of the casting. The silicon is maintained at a point that will insure ease of machining on varying thickness of metal section and the percentage of steel is manipulated to secure a close grain.

Style of Test Block

Two test blocks are cast each day, one from the hard iron mixture and the other from the soft iron. The pattern for the block is shown in Fig. 1 and two castings sawed in two, are shown in Fig. 2. The pattern it will be noted is made up of two parts, one 4 x 4 x 6 inches, the other 2 x 2 x 4 inches. It is apparent that a block of this shape presents a ready means of determining how iron from the same ladle will act when poured in thick and thin castings. The small bar pattern shown in the lower part of the illustration is the regular arbitration test bar prescribed by the society for testing materials and is employed for tensile and transverse tests.

The cubical test block is molded on its side as may be noted by observing the rapping and draw spike holes in the face exposed to the left in the illustration. After the pattern is removed the letter *H* or *S*, depending on whether the casting is to be poured with hard or soft iron, is stamped on the side of the mold. A second stamp on the opposite side of the mold indicates the date and furnishes a ready means, if necessary later, in checking the quality of the iron poured in castings on that date. The mold is made regularly by one of the bench men in a snap flask

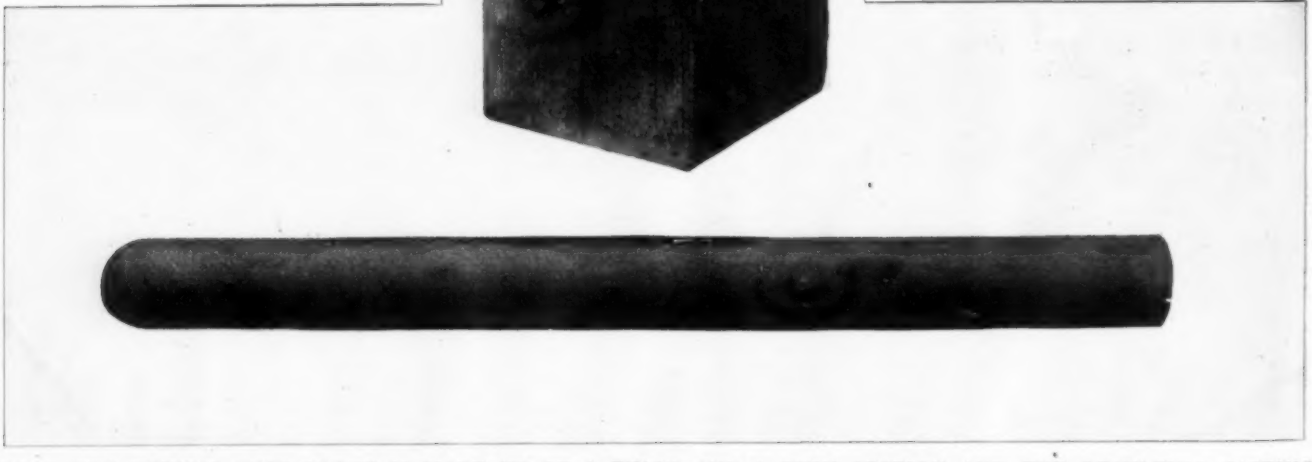


FIG. 1—THE CUBICAL TEST BLOCK IS MADE UP OF A THICK AND A THIN SECTION AND THE RESULTING CASTING WHEN SPLIT OPEN INDICATES THE MANNER IN WHICH IRON WILL SOLIDIFY UNDER DIFFERENT CONDITIONS

and poured through a small gate on the top at one side.

For purpose of comparison and examination the iron block is cut through the center longitudinally, after which a number of blocks are set up on a planer and a light cut taken over the exposed surface to show the grain formation and incidentally bring to light any shrinkage cavities. Two blocks are shown in Fig. 2 and while in all probability the reproduction is not as clear as the original photograph, still enough detail is presented to illustrate the radical difference that may exist between two blocks. The block on the left shows a fine, smooth grained surface with a slight shrinkage cavity in the center. The block on the right presents a coarse, open grain on the exposed surface and the shrinkage cavity is quite extensive.

Reduce Shrinkage

Two features in connection with the test blocks are studied in detail. The grain of the iron and the manner in which it changes between the edges and the center, both on the face of the main part of the block and on the neck furnishes a ready means of drawing definite conclusions. The area, depth and general characteristics of the shrinkage cavity, if any, also are taken into consideration when deciding upon the steps necessary to improve the specific condition. In addition to the foregoing sources of information, the character of the chip formed by the planer tool and the effect on the tool itself, are noted carefully.

As a result of this method of supervision, pursued over a period of several months the test blocks from many heats present a perfectly clean smooth surface without the least evidence of interior shrinkage, a feature that is considered rather remarkable. When the method first was introduced it was not uncommon to discover cavities 2 inches in length and correspondingly deep in the center of the blocks. Recently, in the comparatively few cases where shrinkage is noticeable, it is in the shape of a small porous patch, rather than in the shape of an actual cavity. The number of castings rejected for causes based on porosity and shrinkage have been reduced to an insignificant percentage.

The following incident will serve to illustrate the extreme sensitiveness of the test and also the manner in which the resulting information is applied to prevent a recurrence of undesirable conditions.

Deep cuts on a few large machine tool beds exposed a surface tending slightly toward openness in the grain of texture of the iron. Upon examining the blocks bearing the same date as the castings, a similar formation was noted in the center of the blocks. The handle, by which the small part of the block is known, was dense and solid, but a small area in the center of the block body corresponded with the slightly-open texture of the iron exposed in the bottom of the deep cuts on the casting. Upon checking up on all the elements entering into the cupola charge it was discovered that pig iron from a new shipment had been used. The

FIG. 2—TYPICAL BLOCKS POURED FROM SATISFACTORY AND UNSATISFACTORY IRON—NOTE THE FINE GRAIN IN BLOCK AT THE LEFT

suspected pig iron was replaced by another and the blocks cast from the new mixture were up to the former standard of excellence. In this connection it is interesting to note that the chemical analysis of the two irons did not differ in any essential and yet the resulting castings showed a considerable variation in physical characteristics.

It is stated that the difference between iron carrying an addition of 7½ per cent steel, and iron to which 5 per cent steel has been added readily is apparent from a comparison of blocks cast from each mixture. In some instances where the 7½ per cent steel mixture was a little hard on the tools and where the 5 per cent steel mixture produced an iron slightly open in the grain, a 6 per cent steel addition solved the problem and provided a satisfactory iron for the purpose intended.

It is impossible to lay down a standard formula to be followed blindly through every heat made in the cupola. Pig iron and scrap are not uniform from one shipment to another, or even in any one single shipment and for that reason a constant check of some character is required if the foundryman wants to maintain a uniform quality in his product. Chemical analysis of a few pigs or pieces of scrap selected at random do not reveal all the factors necessary to assist a foundryman in deciding what proportion of each to use to produce castings that will meet definite chemical and physical standards. At the foundry of the Pratt & Whitney Co., the block tests are examined with interest every day and in that manner any tendency to depart from an established standard is detected in its incipient stage and promptly corrected.

Low Wind Pressure

When the method first was introduced it was not uncommon to find an unsatisfactory grade of iron reflected even in the handles of the blocks. Occasionally since that time the quality of the iron has shown some slight deterioration, but on the whole it may be said that the practice has prevented the situation

from at any time becoming very serious, or resulting in many defective castings.

Improved cupola practice is credited principally with the reduction in the amount of oxidized iron, pebbly castings, minute gas holes and shrinkage. Under the new system, a low bed is employed and the blast is furnished at 6 ounce pressure instead of the former pressure of 15 ounces. A simple control has been devised and installed in connection with the blast pipe to prevent oxidation of the iron. The wind for the cupola is supplied by a turbine blower made by the Spencer Turbine Co., Hartford, Conn., and controlled by a blast gate operated from a point on the molding floor where a pitot tube is located. The maximum amount of air that may be introduced without oxidation of the iron taking place has been determined by experiment. The reading on the pitot tube corresponding to this volume is maintained constantly throughout the duration of the heat by occasional adjustment of the wheel operating the blast gate of the blower.

With the proper mixture of iron it has been found that the chips do not break or powder but curl freely from the point of the tool. This is considered satisfactory evidence that the iron is close and yet soft enough to be machined readily. The principal problem, and one that is constantly recurring is to produce an iron that will show up close grained in the large castings and still be soft enough when poured into small castings to mill readily and without damage to the cutters.

No claim is advanced to the effect that ultimate perfection has been attained or that foundry troubles are a thing of the past. However, it is felt that a common sense and easily applied check is available, definite enough and quick enough to assist in remedying faulty conditions before they become serious. Troubles still manifest themselves but confidence is expressed in solving them through further accumulation of experience along the foregoing lines.

European Wage Rates

BY VINCENT DELPORT
(Paris Representative, THE FOUNDRY)

WAGES in America at all times have been higher than in the European countries. Notwithstanding the modifications that have been brought about in conditions of life during the past five years, this fact still remains true, although wages in Europe at present are considerably above prewar rates. Tendencies of French and Belgian labor to appeal for higher wages have not abated, and figures closely approximating the peak of 1920.

The accompanying table gives the wage schedules which apply at present in French and Belgian foundries. These are average figures and are representative of the rates paid by founders of mechanical parts such as turbines, engines, etc. The figures shown for France are for the Paris region where wages are comparatively

Hourly Rates Paid to Workmen

	FRANCE				BELGIUM			
	French francs		Dollars		Belgian francs		Dollars	
Laborers	2.25		0.13½		2.10	to 2.50	0.10½	to 0.12½
Machinists	2.50	to 3.00	0.15	to 0.18	2.60	to 2.90	0.13	to 0.14½
Unskilled molders	2.50	to 3.00	0.15	to 0.18	2.60	to 3.20	0.13	to 0.16
Cleaning room men	2.50	to 3.25	0.15	to 0.19½		2.80		0.14
Furnace laborers		2.75		0.16½		3.00		0.15
Skilled molders	3.25	to 4.00	0.19½	to 0.24	3.40	to 3.80	0.17	to 0.19
Patternmakers	4.00	to 4.50	0.24	to 0.27	3.00	to 3.50	0.15	to 0.17

Belgian iron and steel workers recently were granted a 5 per cent increase which became effective Nov. 2. It is noted that the cost of living in both France and Belgium has mounted steadily until now it has reached approximately 400 per cent of prewar figures. Living costs moved downward slowly during 1921, but began increasing early in 1922 and have advanced steadily throughout the year until at present they have attained high. Skilled labor working on piece work earn about 25 per cent higher wages.

In Belgium, molders of specialties such as cast iron stoves, radiators, etc. receive from four francs ($0.20) to 4.50 francs ($0.22½); malleable molders earn from 4.50 francs ($0.22½) to 5.50 francs ($0.27½).

In France and Belgium the men work 48 hours per week. Working hours in the Belgian foundries are from 7 a. m. to 4 p. m. with a recess of 15 minutes at 8:45 a. m. and 45 minutes at noon. The 8-hour law is strictly enforced in Belgium. Belgian foundrymen point out that many workers, including skilled men who are willing to work overtime have been migrating to France where the 8-hour law is less rigorously observed, and the former claim that for this and other reasons the strict application of this law in Belgium is detrimental to industrial interests.

Prepares a Booklet on Welding Cast Iron

The Linde Air Products Co., New York, has published a 122-page booklet compiled by T. C. Fetherstone presenting interesting information on the subject of welding cast iron. The booklet is elementary in character and for that reason should be particularly valuable to the practical man interested in the subject.

The nature and properties of gray cast iron are treated in an introductory chapter and by way of explanation malleable and white iron are mentioned and their fundamental characteristics given. The effects of the different elements upon the properties of gray iron, questions of strength and other physical properties and methods of casting are presented. The development of welding practice then is discussed and the savings possible through repairing and remodeling or building up are made plain.

The booklet then describes the equipment and procedure incident to proper welding practice and in this phase of the discussion teaches the reader the practical applications of modern experience. Illustrations from photographs and drawings serve to visualize the printed text.

Sell Eastern Shop

All the equipment and machinery in the 29 buildings and yards of Isaac G. Johnson & Co., Spuyten Duyvil, New York, are being sold at auction. Later the buildings also will be liquidated. The company recently went out of business after an existence of many years, owing to the acquisition of the plant site by the state of New York as a result of condemnation proceedings.

The Hayes Brass Foundry Inc. has been removed from 132 Richmond avenue to 1624 North Salina street, Syracuse, N. Y.

Efficient Use of Liquid Fuel

Type of Burners and Amounts of Air and Oil Pressure Influence the Economical Application of Fuel Oil—Use of Insulating Brick and the Grade of Fuel Contributing Factors

BY H. A. ANDERSON

BECAUSE a heat-producing device for liquid fuel can be built easily, oil is one of the most abused of industrial fuels. An oil burning appliance may be inefficient, but by using the fuel economically fair results may be obtained.

Unfortunately the term "oil burner" often is loosely applied to atomizers, which merely spray the oil into the furnaces, which in turn must mix, gasify and burn the oil. A burner cannot rightfully be called a burner unless it actually completes the combustion of fuel without external aid; that is, it must be independent of the furnace. The function of a furnace is not to burn the fuel but to conserve and distribute the heat developed by the burner. The test of a real burner is its ability to completely burn the fuel in the open, without being applied to a furnace. To meet these requirements, a burner must atomize the fuel completely, thoroughly mix the finely divided oil with the correct amount of air, and then gasify the finely divided particles of oil and completely burn the gas. The gasification and combustion of the finely divided fuel must take place in a small area under high temperature, in order to obtain perfect combustion.

The spray burner is the atomizing device used almost universally in the industries. Atomization is accomplished by passing the oil through a nozzle in the path of a jet of air or steam. The velocity of the air or steam divides the oil into a spray which is passed into the furnace for combustion. The velocity of the spray induces additional air for combustion. This type of burner can be classified as follows:

1. High pressure burners operating on air or steam usually at between 50 and 125 pounds per square inch.
2. Medium pressure burners operating on air pressure at from 1 to 15 pounds.
3. Low pressure burners operating on air at between 6 and 14 ounces.
4. High-low pressure burners atomizing oil with high-pressure air and using low-pressure air for combustion.

At the present time the oil burning furnaces in general use are of three types—under-fired, over-fired checkered arch, and side trench-fired furnaces.

In the under-fired furnace the combustion space is below the furnace hearth. This space must mix, gasify and burn the oil and then deliver it to the heating chamber above. The high temperatures of combustion under the tile floor of the furnace greatly reduce the life of this floor which frequently fails during operation, dropping the complete charge into the combustion chamber. The large combustion space increases the heat loss of the furnace and tends to reduce the efficiency of combustion.

The most common method of venting the under-fired furnace is to place a row of openings in the furnace arch. Another method is to use ports in the rear wall, which tends to equalize the temperature in the rear zone of the furnace. Still another method provides vents in the rear wall and door, giving a fairly good circulation of heat with a small, low charge.

Above the Heating Chamber

In the over-fired checkered arch type of furnace the combustion space is above the heating chamber. The atomized mixture is directed against a flash wall for reducing its velocity and further mixing it for combustion. The products of combustion fill this space and escape through the many ports in the arch down to the heating chamber. In this type of furnace the vents are placed along the side walls at the height of the furnace floor. The temperature ordinarily is uniform with small low charges but with heavy charges the heat tends to take the path of least resistance and flows directly to the vents, due largely to the lack of forced circulation. The rate of heating usually is slow because of the large amount of brick that must be heated in the combustion chamber above.

In the trench-fired furnace the combustion chamber is arranged along one side of the furnace, the vents usually being located on the opposite side in order to carry the hot gases over the material to be heated. This type of furnace has the same general characteristics as the under-fired furnace. Temperatures vary considerably from the bridge wall to the opposite side, the areas next to the wall frequently being cold as compared to those on the vented side. To remedy this condition wide furnaces sometimes are fired from both sides and vented in the arch or rear wall.

The over-fired open chamber furnace is recognized as an efficient and fast heater. When equipped with a proper number of combustion type burners rapid heating and high efficiency can be obtained and the temperature and atmosphere can be controlled within close limits. For example, small heat treating furnaces of this type can be expected to operate within 5 degrees, plus or minus, and moderate sized car-type furnaces should operate within 10 degrees, plus or minus, in the same plane of the charge.

Since the walls are exposed only to temperatures slightly above the desired heating temperature the life of linings in this type of furnace is comparatively long. In the case of a heat treating furnace the life of a tile floor is determined by the actual wear of charging and discharging. The tile does not burn out. Practically the only refractories in the furnace that require replacement are in the lining of the combustion-type burner, the life of which varies with the service the furnace is required to perform. In heat treating and annealing furnaces the life of the burner lining ranges from one to two years. In forging and welding furnaces where higher temperatures are required the life is from six months to one year.

Another important factor in the construction of a furnace is the quality of refractory material used, since the efficiency of the furnace depends to some extent on the amount of heat lost through the furnace walls. Ordinary firebrick has a certain insulating as well as refractory property which is measured in terms of the number of B.t.u.'s conducted by one square foot of surface 1 inch thick per degree of temperature per hour. This unit, which is known as thermal conductivity, in the case of average firebrick is between 10 and 12. Many different insulating materials are manufactured for further reducing furnace losses but as many of these are not refractory they must be placed in

From a paper presented before the Southern and Southwestern Railway club, Atlanta, Ga., Sept. 20, 1923. The author is chief engineer, Mahr Mfg. Co., Minneapolis.

back of the firebrick. The average thermal conductivity of these insulating brick is about 1. In other words a 1-inch wall of insulating material is equal in thermal conductivity to about 10 inches of firebrick. Insulating brick pays high returns on furnaces operated continuously but shows small if any savings on furnaces used only a few hours each day because the heat would scarcely penetrate the firebrick in that short period.

Furnaces used for high temperatures such as welding accordingly should not be insulated as the firebrick needs to be exposed to the air for cooling in order to keep it below its melting point.

The color of the surface also is a factor in the heat loss of a furnace. Dark colors, such as black, sometimes radiate enough heat to balance the retarding effect of the insulating brick used in the furnace wall. Light colors including white and light grays, radiate little heat. Light shades of gray are commonly used for industrial furnaces.

Low-pressure air has several marked advantages over high-pressure air in combustion type burners. The cost of producing the air is lower; the refractory lining lasts longer with low-pressure air and the low hum of a low-pressure burner sometimes is considered preferable to the deafening roar of the high-pressure burner.

Keep Oil Free From Dirt

The oil used should be sufficiently fluid to atomize and flow freely. It should be free from dirt and other foreign matter, as these impurities seriously interfere with the proper regulation of fuel in the furnace. The control of oil at low capacities is exceedingly difficult unless the fuel is clean and properly strained before going through the regulating valve. The clogging of an oil regulating valve throws the furnace out of balance, reduces the temperature and changes the furnace atmosphere.

Excessive oil pressures should be guarded against as they have a tendency to cause clogging at the regulating valve. Moreover, high pressures require less opening of the valve, hence small particles easily clog it. For average fuel oil a pressure of 30 pounds per square inch is sufficient. If the fuel is heavy the best way to reduce the viscosity is by a steam heater. The oil also may be heated by running steam pipe lines alongside the oil line. Another method is to place the oil feed line over the furnace vents. However, this method does not take care of the starting period, it being necessary to use a torch to apply heat to the oil line and strainer for starting.

It is not good practice to reduce the viscosity of heavy oils by mixing with lighter oils because it is almost impossible to obtain a thorough mixture. When the oil is not properly mixed a greater amount of thin oil will pass the valve than heavier oil, the result being a pulsating flame which causes the furnace temperature and atmosphere to vary.

There are four methods of feeding liquid fuel to the burners. These are known as the pressure, gravity, standpipe and circulating systems. Perhaps the most commonly used system is the pressure or dead-end system. Pressure is applied to the tank to force the oil to the various pieces of burning equipment. Heavy fuels are difficult to handle with this method because the congealed oil in the pipe lines must be forced through the burners in starting. Dirt and sediment have a great tendency to collect in the pipe lines, due to the small flow. Pressure on the fuel tank is a decided fire hazard.

The gravity system is used in many small plants where only a few pieces of oil burning equipment are used. This system does not work satisfactorily with the heavier fuel oil due to the resistance in the pipe lines, and otherwise has about the same advantages as are found in the pressure system.

The standpipe system with an overflow is similar to the ordinary gravity system. The fuel is pumped to the standpipe and maintained at a constant level by an overflow opening. The fuel is fed to the various furnaces from the oil in lower portion of the standpipe.

Liquid fuels are best handled by the circulating system in which a rotary or reciprocating pump circulates the fuel through a pipe past the oil burning equipment and back to the tank through a relief valve. This valve can be set to maintain any desired pressure in the circulating system. Branch lines to each burner are tapped in on the main circulating pipe. Automatic shut-off valves can be installed on each branch line for protection. The moment the oil pump is started with this system the congealed oil in the main pipe is returned to the tank. The circulation of the oil has a great tendency to reduce the viscosity of the oil and to mix it thoroughly. The starting of an oil burner merely reduces the amount of oil returned to the tank. The flow is free from pulsations when the system is equipped with a rotary pump. If a reciprocating pump is used, an air chamber should be used to reduce the pulsations in the system to a minimum.

Uniform Classification Is Recommended

Dr. George K. Burgess, director bureau of standards, Washington, called a meeting on Nov. 9 of the various scrap producers, consumers and buying interests to consider changes and improvements in the methods of classifying scrap. At present an utter lack of uniformity seems to prevail in this subject. G. C. McClure, American Rolling Mill Co., Middletown, O., representing the Iron and Steel committee of the National Association of Purchasing Agents, presented for consideration tentative specifications formulated by the committee on the following six basic classifications: 1. Scrap for use in blast furnaces. 2. Scrap for use in basic open-hearth furnaces. 3. Scrap for use in electric steel furnaces. 4. Scrap for use in acid open-hearth furnaces. 5. Scrap for use in gray iron foundries. 6. Scrap for use in bessemer converters. Important suggestions were presented on each of the several classifications. At the close of the meeting the conferees agreed that the Iron and Steel committee of the National Association of Purchasing Agents should continue the work under the leadership of G. C. McClure with a view of perfecting the tentative specifications for presentation at a meeting to be held later at the bureau of standards. When the tentative specifications are accepted the bureau of standards will promulgate them in its information series.

Resigns As Manager

W. J. Romaine has resigned as manager of the Boston office of the Sterling Wheelbarrow Co. L. P. Robinson will succeed him in this capacity. The office of the company has been moved from 79 Milk street to room 424 at 200 Devonshire street. Mr. Robinson will retain his present connection with the Werner G. Smith Co.

N. P. Farrar has been made district manager for Pawling & Harnischfeger Co., Milwaukee, manufacturer of excavators, cranes and machine tools. Mr. Farrar will maintain offices at the Stephen-Girard building, Philadelphia, and 50 Church street, New York.

Pilling & Co., Inc., have removed their Philadelphia office to 1400 Bankers' Trust building.

Testing Device Is Easily Made

Reminiscences of a Retired and Prominent Foundryman Cover Interesting Phases Connected with the Subject of Producing Iron That Will Meet Definite Specifications

BY ROBERT E. MASTERS

OVER 30 years ago I stated on the front page of one of our scientific journals that it was a waste of money to employ a chemist in a foundry where foreign scrap formed part of the daily charge. I have seen no reason to change my opinion since that time. The blast furnace furnishes the analysis of the pig iron, but we have to guess at the composition of the scrap and while an experienced foundryman basing his opinon on an intuitive sixth sense developed through years of training, may approximate the anticipated analysis, that is all it is, an approximation.

Where a foundry uses 40 per cent scrap and many use 50 per cent or more scrap bought in the open market and collected from no one knows where, it is extremely problematical if any two pieces analyze alike. Conditions are radically different where a foundry uses no outside scrap. Even there operating conditions must be watched closely, particularly if more than one mixture is attempted during each heat.

Present day foundrymen will be interested in two instances from my personal experience illustrating the relative merits of practical and theoretical foundry knowledge. The first instance did not really come under my personal observation, but was related to me by the late Gen. Joseph R. Anderson, a gentleman of the old school and a prominent iron master who founded the Tredegar Co. in Richmond, Va., in 1846. He was a close personal friend of Robert E. Lee and Jefferson Davis, a gallant defender of the old South, and freely placed his professional services and the manufacturing facilities of his works at the disposal of the Confederacy. However, the story he told me has no bearing on that period, but deals with the last of the cast-iron guns ordered by the United States government.

The order called for 24 guns and was divided equally between the West Point Foundry (Parrots), Cold Springs, N. Y., the Fort Pitt Works, Pittsburgh, now McIntosh, Hemphill & Co., and the Tredegar Co., Richmond, Va. The war department not only specified all the tests to which the guns should conform, but also indicated the analysis and the mixture from which they should be cast. The General notified the department that he would not accept the order under the conditions. He claimed that guns made from the iron specified would not withstand the shock test. However, if permitted to use his own judgment and select his own materials, he guaranteed to produce guns that would withstand any shock test to which they might be subjected on the proving ground. He was given permission to proceed with the work.

Guns Stand Test

At that time guns were tested by selecting one from each lot and subjecting it to six discharges, each charge being equal to a double service charge. The guns made in the other plants according to government specifications burst during the test. The Tredegar guns not only withstood the six regulation test charges, but also resisted the effect of six additional charges and the only noticeable change in their appearance was a slight enlargement of the vent. The guns were accepted by the government and formed the last unit of that character manufactured in this country.

In 1893 the company with which I was connected secured a large car wheel order from the Union Pacific railroad. Among other features the order specified that one wheel was to be selected from each 50 and if it failed to pass certain tests the entire lot of 50 would be rejected. All accepted wheels had to be guaranteed for so many miles passenger service or for so many years freight service. The foregoing always have been recognized as legitimate specifications, but when I found the order also carried a clause indicating what percentage of three different brands of pig iron and what percentage of scrap wheels were to be employed to fill the order I felt that a protest was necessary.

Joe McConnell, later president of the Pittsburgh Locomotive Co., Allegheny, Pa., and known among his intimate friends as Little Joe, was superintendent of motive power and rolling stock on the Union Pacific system at the time and since we had been personal friends for a number of years I decided to interview him on the subject. I found him in his office in Omaha, Neb., preparing to go over the road in his private car to Denver via Cheyenne.

I handed him the order and the specifications with the request that he look them over. He glanced over them perfunctorily and when he asked me what was wrong with them I did not need any fortune teller to explain how the metal mixture feature had come to be incorporated in the specifications.

"Why," I said, "You are grabbing the whole works and giving the foundry no show. When you insist that the foundry use a certain mixture, the wheels are yours and you cannot expect the foundry to furnish wheels that will stand up to certain tests, shock, thermal, years or mileage. You will have to cut out either one specification or the other. If you want the same satisfactory wheels we have been furnishing right along, let us make our own mixture and we on our part will guarantee to furnish wheels that will pass all your tests."

He saw the point and cut out the objectionable feature.

Thirty-seven years ago, in March, 1886, I prepared an illustrated article which was published in the *American Machinist*, describing a simple yet effective method of testing bars to determine the relative strength of the iron in various mixtures. As the device could be made and applied at an approximate cost of $2 and as it would furnish reliable information on which to base their cupola practice I felt reasonably sure that foundrymen generally would appreciate it and adopt it. My expectation was fulfilled to an extent that necessitated the reprinting of the article in a subsequent issue.

For the benefit of younger foundrymen who may be interested in the subject it may be stated briefly that the testing device consisted of an eye bolt suspended through a hole in the center of a flat bar placed across the upper surface of an ordinary small platform scale. In practice the test bars are cast to a uniform length corresponding to the width of the scale. They also are cast to a uniform cross section to in-

sure accuracy in the subsequent reading of results. The bar is shoved through the eye in the bolt and then the bolt is tightened slowly and the weight on the scale beam is increased until a point is reached where the bar breaks. The device is simple, easily constructed and while the tests do not show the transverse strength of the iron on the basis of a 1-inch square section, they do furnish accurate information on the relative strength of one mixture as compared with others, and really that is the only information the average foundryman requires.

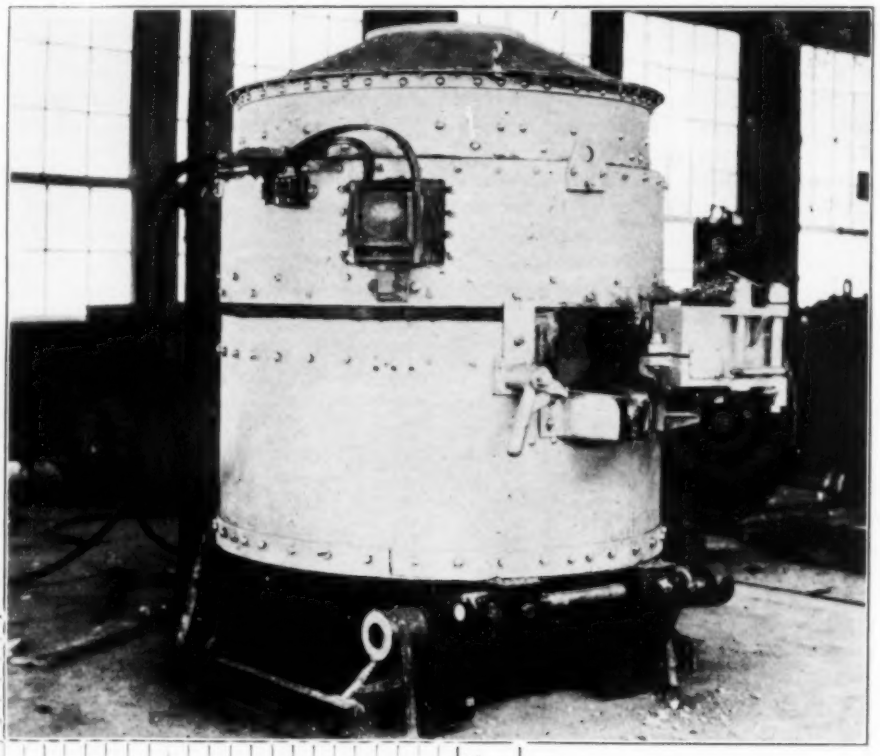
Installs Electric Resistance Furnace

ONE of the new type resistance furnaces manufactured by the Bailey Furnace Co., Alliance, O., has been installed at the plant of the H. H. Miller Industries Co., Canton, O. The alloys made range from yellow brass, bronze and red brass to metals containing 50 per cent nickel. The company has been a user of the former type of Bailey furnace for a number of years, but expects to secure some advantages from the new type over the old.

The requirements laid down for the new installation were more rapid heating up, a faster melting rate and higher temperature range. It was desired to have some convenient means for readily renewing the heating element so as to avoid the long delays in repairs formerly experienced when the resistor trough needed to be replaced. The company also wished to eliminate the piers for the trough supports used in the old type of resistance furnace, so as to obtain a larger furnace chamber capacity which would be particularly desirable when charging light scrap or turnings. As the company occasionally desired to refine metal the new furnace was provided with a magnesite bottom similar to that used in steel melting furnaces. This bottom was baked in place with a temperature of above 3400 degrees Fahr., temperature readings being taken by segar cones placed on the hearth.

Although at the present time only 100 kilowatts are available from the company's power house, the furnace itself has a rating of 150 kilowatts capacity, and a melting rate of 1000 pounds per hour, with a maximum hearth capacity of 2000 pounds. The present requirements of the manufacturer of the furnace are for a maximum heat of 1000 pounds. This size charge of red brass is said to be melted in less than 1½ hours from pour to pour, with a power consumption of 100 kilowatts per hour, or 300 kilowatt hours per ton. It also is said that at full electrical input of 150 kilowatts per hour this furnace has a melting rate of more than 1000 pounds per hour, and a current consumption of approximately 250 kilowatt hours per ton.

From the heating up curve, Fig. 1, it may be noted that the furnace came



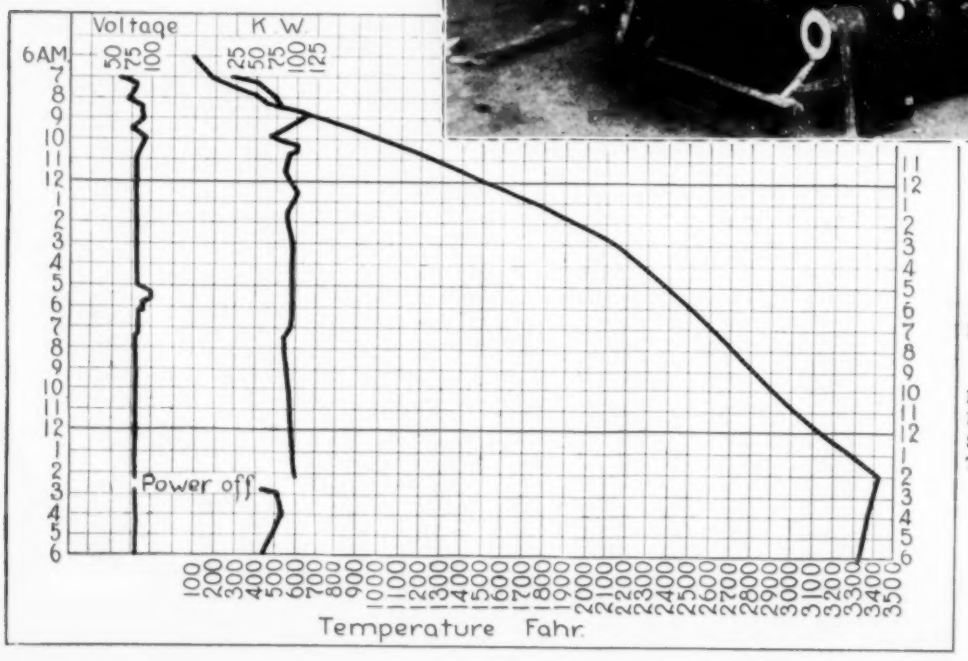


FIG. 1—HEATING CURVE OF ELECTRIC RESISTANCE FURNACE

FIG. 2—THE NEW RESISTANCE FURNACE IS MADE IN THREE SECTIONS, THE MIDDLE SECTION CONTAINING THE RESISTOR TROUGH

from cold to 2500 degrees Fahr. in 11 hours, with an average current input of approximately 80 kilowatts per hour, or 880 kilowatt hours for the period, and reached a temperature of 3400 degrees Fahr. in 19 hours from cold, with an average input of approximately 85 kilowatts per hour, or 1615 kilowatt hours for the entire period.

The furnace itself is made in three parts. The base, which contains the magnesite hearth, comes to the top of the door line. The middle section contains the self-supporting heating element, electrodes and terminals. The roof rests directly upon this middle section. When a new resistor ring is required, the roof is removed and the old resistor section taken off and a spare resistor section, already prepared, is placed in the furnace, the same as though it were a spare roof. To obviate the difficulty experienced in making sound resistor troughs, the new type resistor container is made of special shaped brick sections, which are readily molded and baked without danger of cracking in molding and baking.

The furnace is supplied with a rocker tilting arrangement so that the center of gravity remains in the same plane throughout the pour. As the furnace moves forward, the front lowers and the rear of the furnace raises, the nose of the furnace describing almost the same arc as the stream of metal flowing from the furnace. The tilting of the furnace is done by means of a 2-horsepower motor operating through a double worm reduction, the final worm wheel being keyed to the rear shaft which supports the rear rocker arms. The wall insulation is similar to that in the former furnace.

Pattern Rig for Making Gear Blank

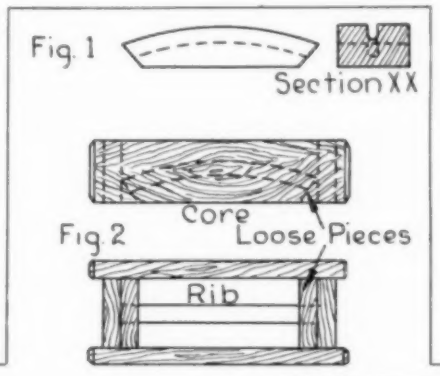
BY M. E. DUGGAN

WHERE only one or two large wheel castings are required the patternmaking expense may be greatly reduced by substituting an arm corebox and a rim segment for the usual complete pattern. Articles in technical magazines and books on patternmaking explain how the work is done, but a patternmaker never will get a thorough grasp of the subject until he goes into the foundry and watches the coremaker and the molder making and assembling a mold on which this emergency rigging has been employed. The pattern rigging required for a 72-inch gear blank, 6-inch face, hub 10 x 10½ inches is shown in the accompanying illustrations.

The patternmaker has to decide on several points before making the layout for the pattern equipment. For example should the casting be made plain on the inside of the rim or provided with a horizontal rib at the center extending between every pair of arms? The proper machining allowance to leave on the top and bottom of the hub and on the face of the wheel. In all probability the casting will not be as true to size and dimension as one made from a full pattern and, therefore, it is advisable to provide a generous machining margin. For a 6-foot diameter wheel ⅜ inch added to the radius and the same allowance on the face and hub usually will be found sufficient.

After deciding on the foregoing points and having a clear conception of the job in his mind, the patternmaker prepares a full size drawing of one arm of the blank, showing the hub, the arm, the sides and outer ends of the corebox and the joint angles at the hub. He also lays out a 1/6 segment of the rim and a single section of the inside rim core. If this drawing is prepared neatly and accurately it will save a great deal of work and worry later. The various parts of the arm corebox are shown in Figs. 3, 5, 6 and 7.

Where wheels of various sizes are made it is customary to make the bottom and sides of the corebox long enough to take in the arm of the largest wheel. In this manner a single corebox will serve for wheels within any reasonable limit. Sometimes it becomes necessary to slip the rim and end piece in or out on the bottom board and at other times when the variation in the size of the wheel requires a radical increase or decrease in the cross section of the arm, an entire new arm section is placed in the box. Where temporary change of the foregoing character is made it is not necessary to waste time over fillets in the cores after they have been



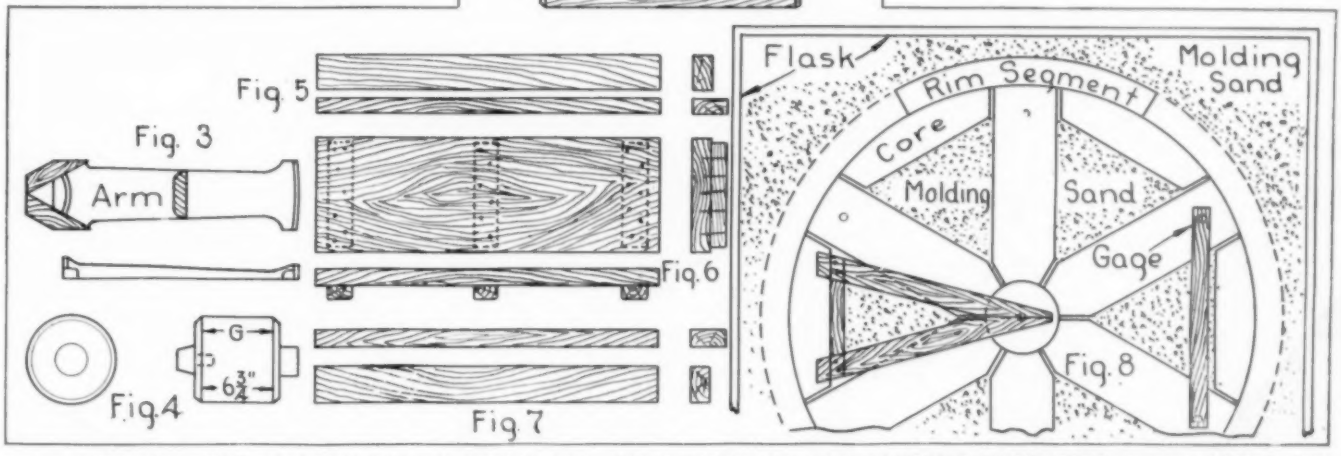


FIG. 1—SEGMENT CORE TO FORM RIB ON INSIDE RIM FIG. 2—COREBOX FOR SEGMENT CORE FIGS. 3, 5, 6 AND 7—DETAIL OF ARM COREBOX FIG. 4—HUB BLOCK FIG. 8—SHOWING METHOD OF LOCATING ARM AND RIM CORES, ALSO SEGMENT FOR FORMING OUTSIDE OF MOLD

dried and pasted, either before or after they are placed in the mold.

In this instance the depth of the arm corebox, 3⅜ inches corresponded to half the depth of the wheel face. In this manner the complete core equaled the height of the rim. Of course in many wheels this condition does not obtain. For example with an exceedingly narrow rim the thickness of sand in the arm core cannot be reduced to correspond. With an exceedingly wide rim it is easier to fill the interior of the mold with green sand instead of providing arm cores thick enough to extend from the top to the bottom.

Two methods were optional in molding the rib on the inside of the rim at the center line. A detachable rib segment might have been secured to the rim segment pattern by long pins extending through to the outside. With this rig the inside and outside of the segment are rammed at the same time up to the center line. Then with the rib firmly anchored in place the pins are withdrawn and the sand is rammed to the top of the segment. The segment is removed first and then the rib is drawn laterally. This procedure is repeated until the entire ring is completed. In the second method the one employed in this instance, a dry sand core was utilized to form the rib and fill the space between the arms close to the rim.

The core and this inner circle corebox are shown in Figs. 1 and 2. The base of the core is flat instead of following the contour of the side that carries the rib. This form of construction is favored to facilitate drying the cores on flat plates. The loose piece in each end of the corebox is removed and the space filled with molding sand before the core is turned on to the plate.

In making the mold, a flat surface is swept either on the floor or on a drag flask. The hub block is bedded approximately in the center of the space down to the edge of the lower shoulder. The arms cores are laid on the bed. They are located on the inner ends by the hub block and on the outer corebox forms a corresponding opening near the end of the core on a center line. The plugs in the gage stick fit in these openings and serve as the points on a pair of trammels in locating the cores. The segment cores forming the inside face of the wheel are located by an A-frame swinging from a dowel pin on top of the hub block. Sand forming the outside of the mold is rammed against a rim segment. The completed ring is covered with coke cores, a suitable core is placed over the hub and the entire mold is covered with a cope rammed full of sand. The runners and risers are made up in the usual manner.

Flushed the Cupola After Pouring a Heat

By Thomas Nelson

Certain features in a series of articles in THE FOUNDRY dealing with cupola practice reminded me of a man who tended the cupola in the little Scottish foundry where I served an apprenticeship at the trade of molding. To be strictly accurate I should say that *I wrought at the mowldin'*, but wrought is a tricky word and I am afraid quite beyond the scope of those not accustomed to it from childhood. The cupola tender's name was Bill, or it would have been Bill had he flourished at another time and in another place. As it was he was known as Wullie. He was a remarkable character in some respects and exhibited a degree of *thrawness* and independence rather in excess of that usually credited to his countrymen.

Under normal conditions the foundry produced from 3 to 5 tons of castings a day. The metal was melted in an old-style, solid-bottom cupola and the material was wheeled up an incline to the charging platform. With the exception of the help he had from a boy for a few hours in the morning Wullie did all the work in connection with the cupola. The most difficult part of the day's work lay in drawing the dump out of the bottom after the heat was poured off. Usually he was employed for half an hour or more with rake and rod and in the meantime the inside of the cupola was cooling rapidly thus producing a mess that required extensive chipping on the following morning. Current tradition in the foundry credited Wullie with having gone into the cupola on numerous occasions while it still was red hot, to chip it out.

After the day's work was over Wullie cut grass on the railroad bank and fed it to a few cows owned jointly by himself and his wife. Eventually he decided that since he had kept the cows many years it was about time they kept him. He left the foundry and was succeeded by a young man named Pete who had acquired some cupola experience through working as a cupola helper in other foundries.

The members of the shop crew naturally were interested and somewhat curious to see how Pete would draw the bottom after all the iron had been tapped out. They were willing to offer either advice or assistance, but Pete showed no inclination to ask for one or the other. He shouted to the boys to *Stan' awa,;* knocked down the door and before we realized what had happened the dump was lying out in the yard and the inside of the cupola was scoured as clean as a drain pipe.

He made no secret of the process which he continued to employ as long as he remained on the job. After all the iron was drained from the furnace he threw in a few shovels of slack coal and a shovelfull of limestone. The wind was left on for about two minutes until all the mess in the cupola was reduced to a liquid slag. The instant the door was opened this material flowed out. Old Wullie had learned to do the work in a certain manner and so far as he was concerned that was the only way in which it could be done and if he had remained, the only way in which it would have been done world without end, amen. Old age is venerable but it is not always infallible.

How to Make Pattern for Loading Mast Cap

Question: In a week or ten days I expect to start work on a pattern for a steel casting to be used as a cap for a loading mast. The general features and dimensions are shown on the accompanying illustration. Will you kindly inform me the best manner to make this pattern to meet the foundryman's requirements.

Answer: Two methods for making this pattern are available and the adoption of one in preference to the other will depend on circumstances. In the first instance, the pattern costs more to make, but the foundry expense is reduced. In the second instance the pattern cost is reduced, but the foundry expense is increased. The net cost to the customer will be about the same no matter which plan is adopted. In both instances the pattern is made to mold closed-end up and with the four lower guy lugs loose and held in place by suitable pins. In the first plan, the pattern is an exact replica of the casting and leaves its own core. In the second instance the pattern is made solid, that is it is closed at both ends and provided with a core print on the lower end. A dry sand core is employed to make the opening in the casting.

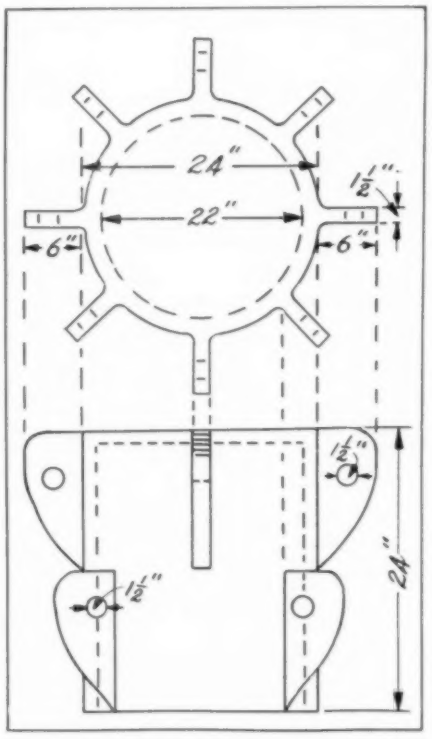
In the first method the staves are fastened to the plain round head at one end and tied at the bottom by a number of lap jointed segments. The four upper guy lugs are attached permanently to the pattern, but the four lower lugs are each attached by two

long nails or pins extending from the inside of the pattern. All the lugs are provided with stop-off core prints. Those on the top lugs are attached vertically and those on the lower lugs are attached horizontally.

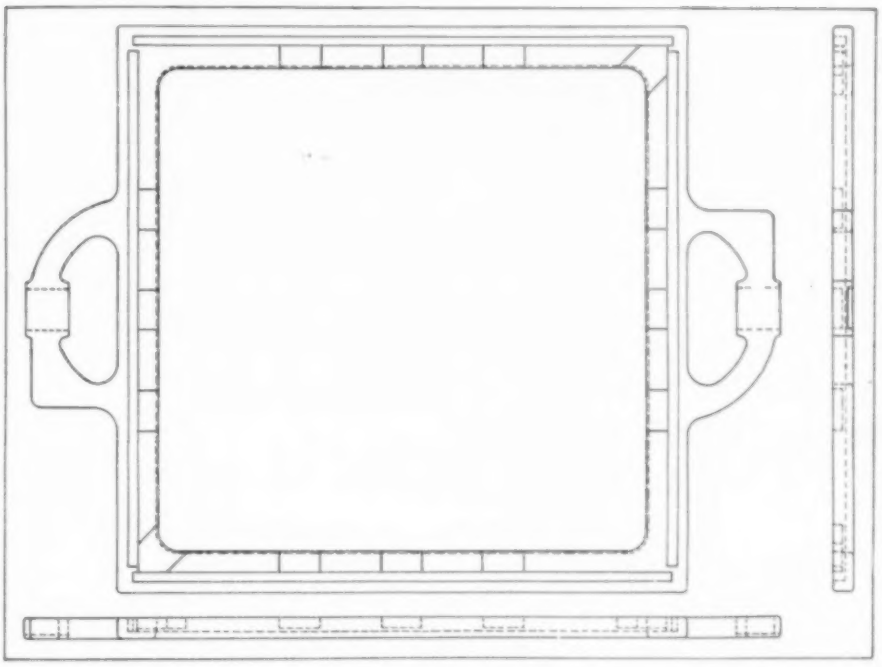
Three-Part Flask

In the foundry the job will be made in a three-part flask. The pattern is set on a board, closed-end next the board. The cheek flask is set on, filled with sand and rammed. The pins then are pulled in, thus releasing the four loose lugs. The pattern then is rapped and a parting made, after which it is filled with sand, rammed and vented. The drag flask is set on, filled with sand, rammed, and after providing for the free exit of the vent from the core, a bottom board is placed in position and then both parts of the flask are clamped together and rolled over. A flat parting is made on the top joint with the exception of four slight depressions over the tops of the four upper lugs.

After the cope has been rammed and lifted off, the pattern is drawn and then the cheek is lifted off and set on a pair of horses where the four loose lugs can be drawn in. The stop off cores are set in place in each of the lugs and after the mold has been washed and dried it is assembled and poured. On a pattern of this description it is essential that a generous amount of draft should be provided both inside and outside.



CIRCUMSTANCES DICTATE WHETHER IT IS BETTER TO MAKE THE PATTERN TO LEAVE ITS OWN CORE OR TO PROVIDE A CORE-BOX—THE LOWER SET OF GUY LUGS ARE MADE LOOSE AND DRAWN IN



DIMENSIONS ON THE FRAME WILL VARY ACCORDING TO THE SIZE OF THE FLASK TO BE EMPLOYED

In the second method a plain drum is prepared in which a number of staves are attached to two *barrel heads* and then a plain round print, which if necessary can be made on the band saw, is fastened to the bottom. The upper guy lugs are attached permanently and the lower lugs attached temporarily as in the first example. A half corebox is provided for making the center core.

Second Is Preferred

The advantage of the second method is that no elaborate fitting is required. Instead of making the barrel heads perfectly round they may be cut in a number of facets to accommodate the width of the staves, say 2 or 3 inches. The staves are attached flat and after the pattern has been built it is trued up in the lathe or by hand, depending on the shop equipment.

With this type of pattern it is not necessary to cheek off the mold, the lugs can be drawn in after the pattern is withdrawn.

Vibrator Frame Designed for Simplicity

By Louis T. Lesperance

The vibrator frame shown in the accompanying illustration was designed primarily for service on a class of castings where individual orders only covered comparatively small numbers and patterns had to be changed frequently. In molding the frame a narrow groove is cored on all four sides. This groove lightens the frame, prevents any disposition to warp and also furnishes a stop or clearance for the tool employed in milling the recess for the pattern support. The frame is machined to a uniform thickness with the top and bottom faces parallel. The recesses to receive the pattern supports on the inside of the frame are laid off accurately from center lines. If only one frame is contemplated this will be an individual job, but if several frames are to be constructed a jig may be employed to advantage.

This stage of the work requires the utmost care and accuracy because on it depends the subsequent matching of the half molds that are made from the patterns. Probably the most important feature of the process is to secure an absolutely uniform depth to the various recesses designed to receive the pattern support. An end mill with a stop accurately set will serve satisfactorily in this respect.

The holes through which the patterns are attached are not shown in the illustration. It is advisable to make the holes at one end perfectly round and the holes at the opposite end elongated. In this manner reasonable allowance is provided for any triffling variation incident to drilling the holes in the pieces that are to hold the patterns in the frame and also takes care of variations between centers arising from distortion of the pattern occasionally. By using the tapped hole on the pattern there is no wear on the frame and the molder easily can change the frame from one set of patterns to another.

THE FOUNDRY

Registered U. S. Patent Office

A semimonthly journal devoted to all branches of the foundry trade

Published by
THE PENTON PUBLISHING CO., CLEVELAND, O.

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SUBSCRIPTION

United States and Mexico.....$3.00 a year
Canada.....$4.00 a year
Great Britain and other Foreign Countries.....£1:0:0 a year
Single Copies.....25 cents
Copies published three months or more previous to date of current issue, 50 cents each.

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Contents

	Page
Foundries on the African Rand	1
Tin Slightly Detrimental to Cast Iron	5
Improves Handling Methods	7
Care of Acetylene and Oxygen Cylinders	10
Physical Factors Affect Iron	11
New Catalog of Sand and Foundry Supplies	12
Suomit Brass Crucible Standard Sizes	12
Symbol Designed to Cut Machining Losses	12
Casting Steel Tools to Shape	13
Issue Corrosion Report	17
Bit Makes the Cup, Saucer and Spoon Mold	18
How and Why in Brass Founding	22
Progress in Gray Iron Industry	24
Guards Core Car Wheels	25
Will Sell Core Binder	25
Fill Holes in Castings	25
Issue Data Magnesium	25
Mixtures Closely Controlled	26
European Wage Rates	28
Prepare Booklet on Welding Cast Iron	28
Sell Eastern Shop	28
Burning Liquid Fuel Efficiently	29
Testing Device Is Easily Made	31
Installs New Electric Resistance Furnace	32
Pattern Rigging for Making Gear Blank	33
Flushes the Cupola After Pouring a Heat	34
How to Make Pattern for Loading Mast Cap	34
Vibrator Frame Designed for Simplicity	35
Turning the Corner	36
Within a Reasonable Time	36
Trade Outlook in the Foundry Industry	37
Personal	38
Tells Foundrymen of Use of Abrasives	38
Will Meet in London	38
Brass Association Holds Annual Meeting	38
Conference for Indiana Foundrymen	38
British Issue Bulletin	38
Obituary	38
Meter Shows Composition of Stack Gases	39
Investigate Sand	39
Designs General Utility Truck	39
Magnetic Separator Built of Steel	40
Castings May Crack from Variety of Causes	40
Many Orders Await New Year	41
What the Foundries Are Doing	42

Turning the Corner

DURING the past month or two, a marked tendency was noted on the part of prospective purchasers of raw materials, plant equipment and all other necessary factors in manufacture to defer all buying decisions until after the first of the year. January first, according to common report, is to usher in a new era. The date is given as the zero hour when industry goes into action on many projects postponed so that the close of 1923 would not show too large an inventory. Nor was the foundry industry any exception in pegging the first of the year for buying. The result has been that inventories are low. With few exceptions yard stocks of iron are not large even for the needs of slackened operations. Coke has not been piled and in some sections fuel is taken directly from the cars to the furnaces. Necessary equipment in many cases awaits only the final endorsement of the proprietor to start it from maker to foundry user. Castings orders, too, have been postponed. Prophesy may be left to those gifted with a remunerative market for its reception, but it must be acknowledged that consumption of all commodities is large. Further, overproduction is not apparent and finally inventories have been maintained at a minimum. Orders, like a log jam where one rests upon another, have been held back with the close of the year. Let's hope January first sees the movement of the key log orders which will serve to release others held back.

Within a Reasonable Time

UNIFORM trade customs, standard order forms and quotation letters from foundrymen to customers contain the phrase which heads this paragraph. As applied commonly it is supposed to describe the interval permitted to elapse between the delivery of castings and their acceptance or rejection for defects. In these days of hand-to-mouth buying, when stocks have been allowed to run low in practically all lines, manufacturers have kept closer within their immediate needs in their castings supplies. Obviously, this has meant that foundries have received prompt reports on castings supplied, for the time between delivery and use has been cut down. With the development which is expected for 1924, longer anticipation of castings needs may lead to a return of what in some lines has come to be an abuse. Foundries have a right to expect a report on their product within such an interval as will permit them to make replacements of defectives before rising prices add a penalty not anticipated in the original contract. Some machine tool plants season castings for months before finishing them, although it is common practice to make a few roughing cuts at once. Automobile manufacturers sometimes buy for delivery 90 days or more ahead of their requirements. The indefinite phrase, *within a reasonable time*, should be jettisoned. In its place in contracts for castings should appear a definite time limit for return of defectives. Thirty, sixty or even ninety days may be used, but at any rate the time limit should permit no misinterpretation.

Trade Outlook in the Foundry Industry

CALM confidence rather than over optimism characterizes the attitude of industry in contemplating the new year. Stocks of goods are not excessive, over production does not exist, no tendencies toward reluctance to buy are noted and the stagnation incident to great number of unemployed is entirely absent. All these factors, negative though they are, influence in a most positive manner the attitude of producers. True, forward buying still is lacking, but in a period of high prices this constitutes a guarantee against sudden and heavy losses. The result is quicker turnover, which in this period of lower profits and intensified competition makes for better business.

Take Up Slack

During 1923 the foundry industry prospered in a moderate degree. Much of the plant capacity which was regarded as excessive for the normal demand for castings was taken up and the close of the year saw the start of new construction to meet the needs of manufacture. This new construction was carefully planned and a noteworthy feature was the attention directed to small details which insure cheaper operation. Foundries which are making no plant additions have shared in this movement to bring down costs and the demand for labor saving equipment seems likely to continue and increase during the coming year. Stocks of metal and fuel alike are low, but no apprehension is felt regarding the ability of transportation agencies to meet immediate needs during the winter season. The greatest freight traffic in American history was recorded during the first 10 months of 1923, totaling 386,027,840,000 ton miles or an increase of 2 2/5 per cent over the previous record established in 1920. Further, the winter season finds the railroads better equipped both in motive power and rolling stock to meet the strenuous demands of cold weather haulage. Expectations of railway buying for next year include from 90,000 to 100,000 freight cars, which will be reflected in castings orders. Locomotive inquiry again is active.

Prices of Raw Materials for Foundry Use

CORRECTED TO DEC. 22

Iron		Scrap	
No. 2 Foundry, Valley	$22.00 to 23.00	Heavy melting steel, Valley	$17.75 to 18.25
No. 2 Southern, Birmingham	21.00 to 22.00	Heavy melting steel, Pitts.	18.50 to 19.50
No. 2 Foundry, Chicago	23.00 to 23.50	Heavy melting steel, Chicago	16.50 to 17.00
No. 2 Foundry, Philadelphia	23.76 to 24.26	Stove plate, Chicago	19.00 to 19.50
No. 2 Foundry, Buffalo	22.00 to 23.00	No. 1 cast, Chicago	21.50 to 22.50
Basic, Valley	20.00 to 21.00	No. 1 cast, Philadelphia	20.00 to 21.00
Basic, Buffalo	22.50	No. 1 cast, Birmingham	18.00 to 19.00
Malleable, Chicago	23.00 to 23.50	No. 1 cast, Buffalo	19.50 to 20.00
Malleable, Buffalo	22.00	Car wheels, iron, Pittsburgh	19.50 to 20.00
Coke		Car wheels, iron, Chicago	19.50 to 20.00
Connellsville foundry, coke	$4.75 to 6.00	Railroad malleable, Chicago	20.00 to 20.50
Wise county foundry, coke	5.75 to 6.75	Agricultural mal., Chicago	19.00 to 20.00
		Malleable, Buffalo	19.00 to 19.50

Foundries Active

Seasonal influences seem not to have affected the foundry industry this year to the same degree as usually is noted. Cast iron pipe shops are busy, while private demand has taken up the slack due to cessation of municipal purchases. The largest maker of cast iron radiators is busy, having replaced in production a number of patterns which were taken out of the sand early in December. Furnace and stove shops have encountered a lull, but still are operating at a higher rate than normally is possible during the mid-winter season. Demand for chemical castings and sugar mill machinery is greater than usual at this period. General jobbing shops are experiencing varied fortunes, depending upon the particular specialties which they feature. Machine tool foundries still are slack, though increased business in machinery lines and railway shop requirements promise improvement for early 1924. The Ohio State Foundrymen's association notes that of 134 foundries reporting only six are not operating and the average operation is 70.29 per cent of capacity. Buying of pig iron dropped away during December, but the potential demand, together with the orders which were booked late in November have tended to strengthen prices to a moderate degree. Foundry coke demand is fairly heavy for first quarter requirements and the number of orders for immediate shipment testify to low stocks in foundry yards.

Automobile Outlook

December automobile production is expected to show a noticeable decline, but no apprehension is felt by manufacturers, as retailers are not overstocked and the Christmas sales were unusually heavy. Confidence is expressed by the heavy orders for steel products placed by automobile makers in the last few weeks of the year. Further, castings orders are coming through in a satisfactory way, and in consequence, foundries making automotive castings will start the year with a promise of satisfactory operations. Many availed themselves of the holiday season to close down, making plant changes and equipment replacements against the anticipated demands of the early 1924 production. Building operations were retarded during November and December, but even with this decrease, 1923 established new marks in constructional lines. November fell short of October by 7.4 per cent in the valuation of building permits issued, but even with this loss November, 1923 was 22.9 per cent ahead of the same month in 1922. The new year is expected to stimulate construction activities, for building has not caught up with the demand, backed up by hampering conditions in the past years. Industrial building in contemplation indicates better conditions in many manufacturing lines. Steel foundries are shown to be less active.

Nonferrous Operations

Brass plumbing goods foundries are operating at about 60 to 70 per cent of capacity, which is unusual for the winter period. Further, dealers and jobbers are not heavily stocked. The aluminum scrap demand indicates that aluminum foundries are busy. Nonferrous foundries making automobile castings are operating on a fair schedule, one large firm making bronze gears working two turns instead of three as was the custom during the summer. Prices for nonferrous metals, based on New York quotations in the *Daily Metal Trade* of December 22 follow: Casting copper 12.75c to 12.87½c; electrolytic copper 13.12½c to 13.25c Straits tin, 47.12½c; lead, 8.00c; antimony, 9.50c; nickel, 32.00c; aluminum, No. 12 alloy, open market, 22.50c to 23.50c. Zinc is 6.25c, E. St. Louis, Ill.

Personal

Col. Oscar H. Fogg has resigned as secretary-manager of the American Gas association to accept the position as president and general manager of the Baltimore Gas Appliance & Mfg. Co., Baltimore.

Homer C. Elliott recently has been made foundry superintendent for the Production Machine Co., Greenfield, Mass. Mr. Elliott entered the industry 22 years ago as an apprentice molder in a jobbing foundry in Rockford, Vt.

Walter A. Horn has been placed in charge of the foundry cost department of the Hay Foundry & Iron Works, Newark, N. J. Mr. Horn for the past four years was connected with the Syracuse Chilled Plow Co., Inc., Syracuse, N. Y. Previous to that time he was connected with the Waterous Engine Works Co., Ltd., Brantford, Ont., Canada, and the Buffalo Pitts Co., Buffalo, N. Y.

Tells Foundrymen of Use of Abrasives

The new art of machining by use of abrasives is making rapid progress in manufacturing, according to F. B. Bowman, Carborundum Co., Niagara Falls, N. Y., who addressed the New England Foundrymen's association at its meeting in Boston, Wednesday, Dec. 12. Mr. Bowman's talk was illustrated with a five-reel moving picture which followed the history of abrasive wheels and abrasive paper from the Niagara Falls power development through to the manufacturing plants throughout the country where finished articles of widely diversified character are produced. The use of abrasives in many industries was shown in considerable detail.

As this was the last meeting of the year the nominating committee for the officers of 1924 was appointed by George A. Ray, president. This committee consists of B. M. Shaw of the Walker Pratt Co., Boston; H. E. Wetherbee of James Hunter Machine Co., North Adams, Mass., and E. H. Ballard of the General Electric Co., Lynn, Mass.

Brass Association Holds Annual Meeting

Officers were elected at the annual meeting of the National Association of Brass Manufacturers, held recently at the Hotel Astor, New York. The new officers are as follows: President, John B. Brazier, West Virginia; first vice president, H. F. Alberts, Ohio; second vice presidents, R. L. Ottlse, D. M. Hamilton, Michigan; E. F. Niedecken, Wisconsin; L. D. Lawnin, Missouri; Joseph Arth Jr., Ohio; Herman M. Hoelscher, Illinois; Wilson Cary, Maryland. To the United States chamber of commerce: E. T. Eckhouse, Ohio councillor; R. B. Hills, Massachusetts, delegate. National Trade Extension bureau: L. D. Lawnin, Missouri, director. L. O. Deutsch, Ohio, and J. M. McDonald, Jr. Iowa, advisory committee.

Among the more important matters handled at the convention was the new nomenclature of articles manufactured by members of the association, as follows:

Formerly Called	Names Adopted
Bibbs	Faucets
Stops	Stops
Stops and Wastes	Stops and Drains
Lavatory Stops	Lavatory Stops
Reversible Stop and	Reversible Stop and
Stop and Wastes	Stop and Drains
Self-Closing Stops	Self-Closing Stops
Urinal Cocks	Urinal Stops
Sill Cocks	Lawn Faucets
Garden Hose Valves	Garden Hose Faucets
Boiler Drain Cocks	Sediment Faucets
Ball Cocks	Float Valves
Drain and Well Water Cocks	Drain and Well Water Valves
Basin Cocks	Lavatory Faucets
Bracket Basin Cocks	Bracket Lavatory Stops
Pantry Cocks	Pantry Faucets
Double Pantry Cocks	Double Pantry Faucets
Double Basin Cocks	Double Lavatory Faucets
Double Shampoo Cocks	Double Lavatory Shampoo Faucets
Slop Sink Cocks	Slop Sink Faucets
Bath Cocks	Bath Faucets
Ground Key Stops	Ground Key Stops
Ground Key Stop and Wastes	Ground Key Stop and Drains
Corporation Cocks	Corporation Stops
Gas Service and Meter Cocks	Gas Service and Meter Stops

Will Meet in London

Arrangements are being made to hold the autumn meeting of the British Institute of Metals in London next year instead of in some other part of the country as usual. This means that there will be two meetings of the institute in London in 1924, on account of the British empire exhibition.

Conference for Indiana Foundrymen

The engineering extension service of Purdue university announces the second annual conference of Indiana foundrymen which is to be held at Purdue university on Jan. 17 and 18. This conference will be of interest to manufacturers using foundry products as well as to foundrymen. No effort is being spared to secure men of national reputation along foundry lines to lead in the discussion of foundry problems and a very interesting program is assured.

A similar meeting held last year resulted in the formation of the Indiana Foundrymen's association and the first annual meeting of this association will be held in connection with this conference.

British Issue Bulletin

The British Cast Iron Research association has issued its second *Bulletin* containing a compact resume of published data on such subjects as foundry sands and clays, growth of cast iron, chilled rolls, corrosion, general foundry practice, molding sands, refractories and numerous other subjects of interest to foundrymen. An important section comprises a series of articles upon foundry sands and clays with particular reference to the employment of greater proportions of used sand in molding and coremaking operations. The Research association is now carrying out exhaustive sand tests.

A large portion of the booklet is devoted to extracts and summaries of recent papers from the technical journals of Europe and America. An important section is devoted to practical foundry data conveying hints to the foundry worker in regard to such matters as gas holes in castings, leaky castings, core sands, etc. A useful list of recent technical publications occupies a page at the end of the *Bulletin.*

Obituary

Michael P. Murphy for the past 20 years foundry foreman at the railroad shops of the Southern Railroad Co., Manchester, Va., died on Nov. 6 at the age of 67. He was chairman of the executive board of the International Molders union for many years prior to his resignation in 1903 when he assumed his duties as foundry foreman. In his capacity of foundry foreman he established an exceedingly creditable record. In fact there is a tradition to the effect that during the entire period he had charge of this foundry he never lost a locomotive cylinder casting. The late Mr. Murphy was born in Richmond, Va., March 10, 1856 and served his apprenticeship at the molding trade at the Talbot & Sons Foundry, in that city.

E. R. Swanson, official of the Keokuk Steel Casting Co., Keokuk, Iowa, died Dec. 13. For a number of years Mr. Swanson was connected with the Duquesne Steel Foundry Co., Coraopolis, Pa., as superintendent and as works manager. Two years ago he accepted the position with the Keokuk Steel Casting Co., which he held at his death.

Harry R. Riley, a member of John J. Riley & Co., gray iron and brass founders, Brooklyn, died Nov. 21 at his home in Brooklyn.

Meter Shows Composition of Stack Gases

The Bacharach Industrial Instrument Co., Pittsburgh, recently has introduced a CO indicator built on the same principal as the CO_2 meter which fills the need for an instrument to indicate the CO content. Diagrams of the new CO meter is shown in the accompanying illustration.

The operation of the meter is based on the catalytic action of a heated platinum wire in producing combustion of CO with oxygen. Referring to Fig. 1, *A* and *B* are two small platinum wires, each passing through the center of cylindrical chambers in two separate metal blocks. *B* is the comparison wire, and *A* is the measuring wire in the chamber through which the sample of flue gas passes slowly. The wires are heated to a temperature of about 800 degrees Fahr. by an electric current. Usually enough oxygen is present in the waste gases for the combustion of the CO and hydrogen but to make certain of this, air to the amount of 20 per cent of the gas volume is admitted through the small passage shown at *E*

The catalytic action causes the CO and H_2 to burn along the surface of the wire *A*, thereby raising its temperature and increasing its resistance in almost exact proportion to the amount of these gases present. When considerable amounts of CO are present, the wire is heated to a brilliant glow. As *B* maintains constant temperature and resistance, the wheatstone bridge circuit, consisting of the wires *A* and *B* and the resistances *C* and *D*, becomes unbalanced, and causes an indication on the galvanometers *F* and *H*. These instruments are calibrated in percentage of CO or CO plus H_2. As the combustion heat of a given volume of H_2 is almost identical with that of CO, the CO meter may serve for a mixture containing both gases. For boiler house practice it is not necessary to know what fraction of the sum is CO and what fraction is H_2; the important thing is the indication that these combustibles are present and to what extent combustion is incomplete. Methane or other hydrocarbons are not indicated but they occur only in small quantities except where the CO content is extremely high.

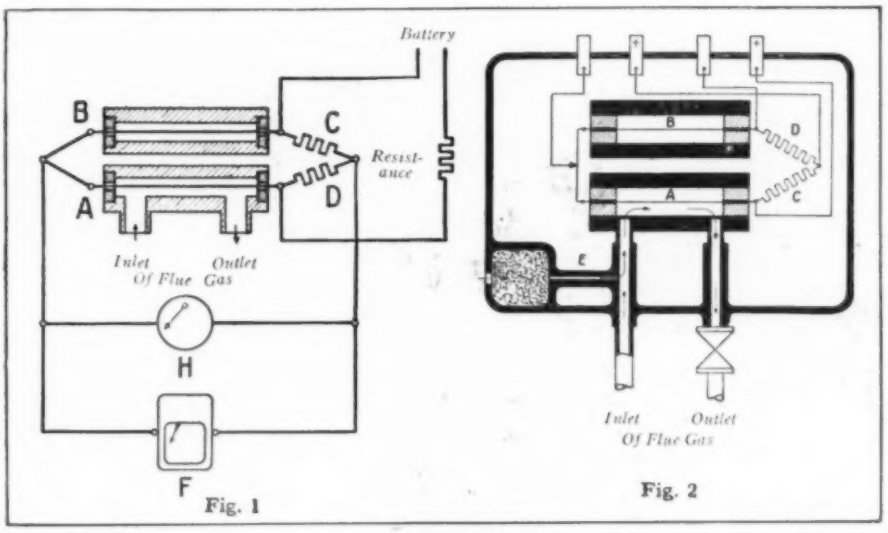


FIG. 1—WIRING DIAGRAM OF CO METER. FIG. 2—SECTIONAL DIAGRAM OF INSTRUMENT

Investigate Sand

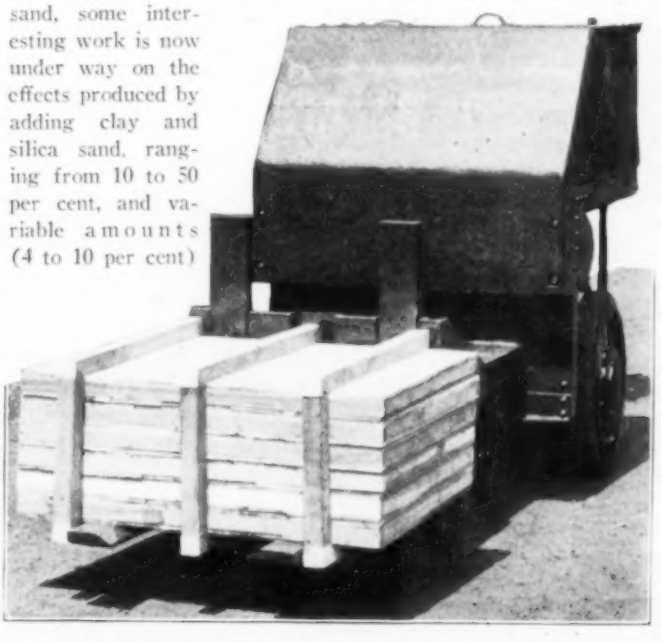
In connection with the investigation which the bureau of standards has been carrying out on foundry molding sand, some interesting work is now under way on the effects produced by adding clay and silica sand, ranging from 10 to 50 per cent, and variable amounts (4 to 10 per cent) of water, to a used foundry sand. It has been shown by the test methods in use that by adding 40 per cent of clay, 25 per cent silica sand to be used sand, and tempering the batch with 8 per cent of moisture, a bond strength and permeability can be attained equal to that of a good brass molding sand. Further tests are in progress.

Will Teach Welding

The Gas Products association, 140 S. Dearborn street, Chicago, recently appointed an educational committee to co-operate with trade and technical schools all over the county in supplying a practical and standard course in welding procedure. The users of oxyacetylene welding equipment have never been thoroughly satisfied with the work done by welding school graduates, and at the same time the application for the welding processes has been extended to so many new fields that the demand for skilled operators is constantly increasing. It is thought that by making a thorough investigation of the needs of the industry and then making recommendations to welding school instructors, the instruction programs can be revised and standardized so as to more fully meet the requirements of the employers.

Designs General Utility Electric Truck

To enable one man to handle 2500-pound loads in all parts of the factory or mill yard, the Elwell-Parker Co., Cleveland, recently has introduced a new type of lift truck. This new carrying mechanism consists essentially of an electric truck with provisions made for the carrying of loads beyond the front axle. The platform, which is made up of a set of forks, is so arranged that it can be lowered to the floor if necessary and can be stopped at any point between the upper and lower limits. The forks are relatively thin, which allows the outer ends easily to be inserted beneath a bundle, box, bale,



LIFT TRUCK WITH A CAPACITY OF 2500 POUNDS

barrel, casting or any irregular shaped piece weighing up to 2500 pounds.

The length of the arms of forks depends on the weight carried since the load placed on the platform must be balanced by the weight of the truck back of the axle. To take care of the great weight the front axle is of a special design with wide spread roller bearings. Steering is accomplished through both front and rear wheels. The raising mechanism consists of a separate motor with worm gear reduction attached to a movable platen supported on the truck frame by means of three rocking links. This electric lift mechanism is simple in construction and is assembled as a unit.

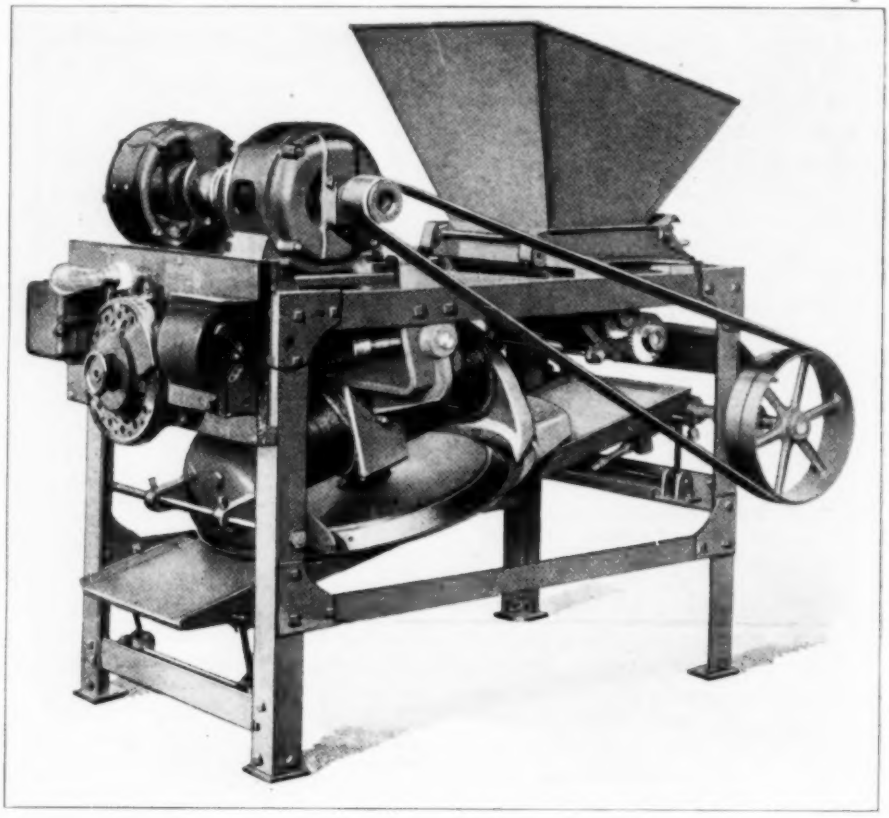
The power or propelling unit of this truck consists of a heavy duty motor and controller direct connected through a flexible coupling to worm and wheel with bevel pinion differential running in oil. Drive shafts with chrome vanadium universal joints and with clutch plate bolted to the outside of the wheels complete the full floating drive axle. To avoid any kick-back at the steering handle when the wheel hits a floor obstruction, the knuckles on both the drive and the front wheels are located close to the center of the tires. A view of the new machine is shown in the accompanying illustration.

Magnetic Separator Is Built of Steel

A new type of magnetic separator involving many new and useful improvements, recently has been introduced by the Magnetic Mfg. Co., Milwaukee, Wis. Contrary to the usual custom in designing magnetic separators, this device is constructed entirely of metal. Heretofore it has been thought necessary to construct a portion of the machine of wood or some other nonmagnetic material in order to confine the magnetic lines of force to a point where the separation actually takes place. The frame on this machine is constructed of steel firmly bolted together. It is claimed that in this design there are no leaks of magnetic lines of force and that the magnet does not affect the steel frame in any way.

The magnet used is exceptionally strong since the design allows considerable wire in the coil windings. All electrical connections and lead wires are enclosed in an improved metal flexible conduit, and all electrical and mechanical parts are readily accessible. The entire magnet including the rotating magnet yoke is above the shaker. This feature causes the magnetic particles to be pulled out of the path of the material on the shaker. The magnetic materials are lifted sufficiently high to readily pass the nonmagnetic material on the shaker. The rotating pan conveyor, to which the magnetic particles attach themselves, carries these particles to the side of the shaker and automatically discharges them.

To keep the shaker parallel to the separating magnet, an eccentric adjustment is provided. A shaker adjustment is provided so that the coarse as well as the fine materials can be handled. After the shaker adjustment has been set in the proper position to effect the proper separation it can be locked securely. Uniform coil windings are provided and the electrical connections are made so as to be easily changed from one voltage to another. The standard windings are for 110 or 220 volts direct current. The separators are provided with tight and loose pulleys for belting direct to the lineshaft, or can be furnished with motors mounted on the separator. A view of the machine is shown in the accompanying illustration.



MAGNETIC SEPARATOR HAVING MAGNET ABOVE SHAKER

The Ferro Machine & Foundry Co., Cleveland, has awarded a contract for a cleaning building 120 x 200 feet to the H. K. Ferguson Co., Cleveland. This building is to be completed in 60 days. A. G. Simon is engineer for the Ferro company.

Castings May Crack from Variety of Causes

Question: We have had some rings 6-feet diameter, 8 feet high, 1½-inch thick, crack at the bottom, some of the cracks extending from 8 to 18 inches. The castings were poured through gates at the bottom of the cores and there was no chill on the bottom. Do you think the cracks were caused by hard iron?

Answer: Without further particulars it is impossible to say what caused the ring castings to crack. The trouble may have been due to hard iron; a hard core; ill proportioned metal thickness; gates that resisted contraction; or any one of several other causes. You do not state whether the castings were made in green sand, dry sand or loam molds; or whether they were made in a flask or in a pit in the floor. Satisfactory castings may be made by any one of the methods listed.

The Chicago Pneumatic Tool Co., New York, announces the General Machinery Co. of Spokane, Wash., as their agents in the eastern part of the state of Washington and northern Idaho.

Charles K. Wehn has been appointed in charge of sales of Standard Steel buildings with offices at the Peoples' Gas building, Chicago, representing the Blaw-Knox Co., Pittsburgh.

Many Orders Await New Year

December Proved Better Than Expected for Foundry Equipment Manufacturers and Orders Pending Make the Outlook Bright for Future Business— Considerable New Construction Being Planned

FOUNDRY equipment firms generally see promise of active business during the early part of the year. December has proved better for many firms than was expected and numerous orders are held for the turn of the year, both for increasing the equipment in foundries already operating and for new projects. The Hoover Suction Sweeper Co., Canton, O., is reported to be considering the erection of a new foundry, and the Richmond Radiator Co., New York, is contemplating the installation of equipment for continuous molding and pouring of radiator castings. The Bessemer Gas Engine Co., is making a study of modern foundries with a view of building and equipping a new foundry at Grove City, Pa. Ilarduya y Cia, Oficinas y Almacenes. Apartado 262, Bilboa, Spain, would like to get in touch with large manufacturers and dealers in foundry equipment and supplies in this country with the object of acting as representative for the sale of their products in Spain. A number of electric furnaces have been sold recently. Among these sales is that of a 1-ton direct arc type steel furnace for the Welland Steel Castings Co., Ltd., Welland, Ont. This company has been organized recently with a capital of $100,000 to manufacture electric steel castings. The Volta Mfg. Co., Ltd, Welland, Ont., which sold the furnace, also sold a 6-ton direct-arc type electric furnace to the Japanese navy department. The sale was made through the New York office of the Imperial Japanese navy. The W. W. Sly Mfg. Co., Cleveland sold a sandblast mill to the Albion Malleable Iron Co., Albion, Mich, and dust arrester equipment to the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich. The same company also sold tumbling mills to the Holmes Foundry Co., Port Huron, Mich., and to the Ferro Machine & Foundry Co., Cleveland; four to the former and eleven to the latter.

Inquiries Numerous In East

WHILE buying has been light during the past two weeks owing to holiday influences, a revival in demand for foundry equipment is expected shortly. New appropriations and the passing of the inventory season are expected to result in considerable buying. This is indicated by the number of inquiries which have been held up over the closing weeks of the past year.

Among scattered orders placed recently is a cupola for the American Car & Foundry Co. This order went to the Whiting Corp. Additional equipment has been purchased by the American Car & Foundry Co.; in fact, this interest, has been a steady buyer for several weeks. Considerable interest was centered on the recent auction sale of the plant of Isaac G. Johnson & Co., Spuyten Duyvil, New York City, which was purchased by the state sometime ago and which will shortly be dismantled. Included in equipment disposed of, was a 3-ton Moore electric furnace, purchased by the Otis Elevator Co., for its plant at Buffalo. The furnace cost the Otis company $12,000, and will displace the the two electric furnaces now installed. A 15-ton Shepard electric crane, with 55-foot span, was sold for $500, and a 5-ton Pawling & Harnischfeger crane, 31-foot span, for $700. The cranes were disposed of upon different occasions and were bought by metal dealers. Several molding machines and air furnaces and a number of flasks went to the Eagle Foundry Co., Passaic, N. J. The Union Stove Works, Peekskill, N. Y., purchased a sandblast mill from W. W. Sly Mfg. Co., Cleveland, and the International Harvester Co., Auburn, N. Y., secured dust arrester equipment from the same company.

Little is noted in the way of new foundry construction. However, a number of projects are pending more favorable weather conditions. Included in new work now under contemplation is a one-story foundry for the Fairmount Foundry & Machine Co., Philadelphia. Construction will get under way this spring. Plans are being prepared by the Stanley G. Flagg & Co., Philadelphia, for the erection of a foundry building to replace the structure which recently was damaged by fire.

Expansion Noted In New England

FOUNDRY equipment sales have slowed up since the middle of December and are not expected to improve until the middle of January. However, several new foundries are in the market for miscellaneous equipment. The newly organized Leonard & Hamilton Foundry at Taunton, Mass., is rehabilitating an old foundry and is in the market for molding machines and other tools. Leland & Gifford Co. of Worcester, Mass., has obtained control of the Putnam Foundry Co., Putnam, Conn., and among other things will manufacture radiators at Putnam, and will require new tools and probably a crane. The Wurster Co. of New York which took over the Concord Axle Co. at Concord, N. H., some time ago, has now turned over its foundry business to Beaupre Bros., Franklin, N. H. This latter concern is asking for quotations on several molding machines and may put in a new cupola. The Gurney Heater Co., Framingham, Mass., is in the market for miscellaneous foundry equipment and supplies in connection with an increase in production. Sales were made by the W. W. Sly Mfg. Co., Cleveland to the Saco-Lowell Shops, Lowell, Mass., one cinder mill; and to the H. & B. American Machine Co., Pawtucket, R. I. one tumbling mill.

Look For Sales Early In Year

FOUNDRY equipment manufacturers in general in the Chicago district find inquiry brisk and the outlook for sales early in the new year good. The Chicago board of education has a committee investigating various makes of equipment prior to purchasing a small cupola, two 14½ x 18-inch molding machines and two electric vibrating machines. The Whiting Corp. reports a cupola sale to each of the following companies: Des Plaines Foundry, Des Plaines, Ill.; the Birmingham Stove & Range Co., Birmingham, Ala.; the Saco-Lowell Shops, Boston; and the Essex Foundry, Newark, N. J. The National Engineering Co. has sold sand-mixers to James B. Clow & Sons, Chicago, and the Pratt & Letchworth Co., Buffalo.

Pittsburgh Reports Activity

COMPARED with other years at this season, the foundry equipment market is active in the Pittsburgh area from the standpoint of both inquiries and sales. One development of importance to sellers here is the start made on its buying program for its new Baltimore plant by the Standard Sanitary

Mfg. Co. It has just awarded three cupolas to the Whiting Corp., Harvey, Ill., and two large blowers to the P. H. & F. M. Roots Co., Connersville, Ind. Its miscellaneous foundry equipment and cranes however, probably will not be placed until early next spring. The Westinghouse Electric & Mfg. Co., Trafford City, Pa., purchased a large tumbling mill from the W. W. Sly Mfg. Co., Cleveland. The same company closed on two ladles with the Whiting Corp., which also sold a 36 x 48-inch tumbling barrel to the Milwaukee Gray Iron Foundry Co., Milwaukee; a 7-ton bottom pour ladle to the Valley Rolling Mills Co., New York City; and core oven equipment to the Richmond Radiator Co., Uniontown, Pa. The Pittsburgh Malleable Iron Co., bought nine fairly large grinding machines and the American Steel Foundries is scheduled to buy some shortly after the first of the year. This latter interest now has an inquiry out for ladles. The Elliot Co., Jeannette, Pa., bought two radial drills. Sales of molding machines by the Herman Pneumatic Machine Co., Zelienople, Pa., made during the past few days, brings its total for the year to more than 150 units, making one of the largest years in its history. Live inquiries pending before it were never more numerous, so that the outlook at least for the first quarter of 1924 is exceedingly bright and encouraging. Three large car-wheel molding machines were sold to the Griffin Wheel Co. Two large machines were ordered by the Lebanon Steel Foundry Co., Lebanon, Pa., and the Commonwealth Steel Co., Granite City, Ill., increased its order from four to six. Single molding machine installations have been ordered by the Chapman Valve Mfg. Co., Indian Orchard, Mass., the Raritan Foundry Co., Raritan, N. J., the Interstate Foundry Co., Cleveland, and the Dayton Malleable Iron Co., Ironton, O. In the crane market a few single crane installations have been placed under contracts, such as the 5-ton crane wanted by the McKay Foundry Co., Youngstown, O., with a Michigan builder. The Southern Wheel Co., Birmingham, Ala., closed on seven cranes with the Whiting Corp.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

Franklin Brass Mfg. Co., 1615 North Second street, Philadelphia, was damaged by fire recently with $5000 loss.

A. N. Williams Foundry & Machine Co., Akron, O., has been incorporated for $500 by H. Lloyd and William C. Franz.

Consumers Foundry Co., Inc., New York, has filed schedule in bankruptcy with liabilities of $17,927 and assets of $11,800.

Fairmount Foundry & Machine Co., Fifteenth and Indiana avenue, Philadelphia, plans a 1-story foundry building to be constructed in the spring. D. H. Redman is president.

The Canadian Iron Foundries, Ltd., Fort William, Ont., will purchase machinery and equipment for furnace room and foundry to replace that recently damaged by fire.

Kensington Davis Co., Buffalo, N. Y., has awarded contract to Austin Co., Cleveland, for $125,000, 1-story, 140 x 304-foot foundry building.

Davenport Machine & Foundry Co., 1616-44 West Fourth street, Davenport, Iowa, operator of gray iron, brass and aluminum foundries, was damaged by fire recently with small loss.

The Williams Foundry & Machine Co., Akron, O., has been incorporated for $500 by H. Lloyd Williams, C. Franz, H. E. Andress, D. W. Maxon and C. G. Wise.

Arlington Foundry Co., Arlington, Mass., operated by Harold M. Twombly, Tewksbury, Mass., and Frank M. Amazeen, have filed a voluntry petition in bankruptcy.

Vilter Mfg. Co., 872 Clinton street,, Milwaukee, operator of gray iron foundry, has let contract to Meredith Bros. Co. for 90 x 125-foot pipe shop addition.

Union Sanitary Works, Noblesville, Ind., operator of gray iron foundry, was damaged by fire recently with loss of $2500 to foundry department which was closed until repairs could be made.

A. & F. Brown Co., Elizabeth, N. J., was damaged by fire recently with loss of about $25,000 to building at Third street and Clark place. The company operates a gray iron foundry.

McChesney Foundry & Mfg. Co., Alhambra, Cal., recently incorporated as the Southern California Foundry Co., for $100,000, has purchased a 2-acre site and will construct plant at 1170 Westminster avenue.

Iowa Malleable Iron Co., Fairfield, Iowa, operator of malleable iron foundry, plans 1-story, 2-section, 100 x 140-foot and 100 x 125-foot brick and concern addition, costing about $100,000. W. W. Hughes is secretary.

The Fremont Brass & Bronze Co., Fremont, O., has been incorporated for $600 by O. C. Wahl, G. C. Hein, Frank J. Hein, Chris Wahl and Chester A. Culbert to operate a brass foundry, etc.

The Buckeye Bronze Casting Co., Toledo, O., recently incorporated for $10,000, plans taking over a plant located at Field avenue and Clover Leaf railway. George Bennett is one of the incorporators.

Fox Foundry Works, New York, has purchased a 50 x 100-foot site for a 6-story foundry in the Hunts Point section. Address company, care of Manida Building & Construction Co., Manida street, New York.

The Waterbury Farrell Foundry & Machine Co., Waterbury, Conn., has let contract for 2-story, 48 x 54-foot addition costing approximately $40,000 to Immick Co., Meriden, Conn.

The Chatfield Foundry Co., Escanaba, Mich., will merge its company with that of the Nau Brass Foundry, Manistique, Mich., recently purchased. Both companies will operate in the Chatfield plant.

Wistrand Mfg. Co., Galva, Ill., has decided to discontinue foundry operations and turn the plant into a general machine shop. Pumps and pump jacks will be the principal product of the company.

Walter K. Wood Mowing & Reaping Machine Co., Hoosick Falls, N. Y., operator of three gray iron foundries, has had John T. Norton, Troy, N. Y., appointed as receiver in equity.

The new gray iron foundry established by John Fischer, John Matowski and Frank Fischer has been changed to corporate form as the Layton Park Foundry Co., with $25,000 capital stock.

Welland Steel Castings, Ltd., Welland, Ont., has been incorporated for $100,000 by William M. German, Allan L. Brooks and Minnie Factley, to carry on business of iron master and iron and steel manufacturer.

Prime Mfg. Co. 653 Clinton street, Milwaukee, is taking bids through Frank D. Chase, Inc., Chicago, engineer, on a 60 x 120-foot addition to be equipped with electric furnaces for general brass casting work.

Kissel Motor Car Co., Hartford, Wis., was damaged by fire recently with about $30,000 loss. Repairs will be made at once. The company operates gray iron, brass and aluminum foundries.

Cambridge Crucible Steel Casting Co., Cambridge, Mass., has been incorporated with $20,000 capital to manufacture and deal in metal products, by Joseph P. Kline, Boston, James C. Doherty, Brighton, and William A. Mann, Neponset, Mass.

Robey Foundry Co., 5815 South Robey street, Chicago, has been incorporated to conduct general foundry business with $15,000 capital stock, by James Safferd, Ernst Ganser and Mathias Prashek, with Otto Kerner, 139 North Clark street, as attorney. No equipment will be bought at present.

H. L. Baumgardner Corp. 5525-38 West Sixty-sixth street, Chicago, has been incorporated to manufacture and deal in foundry and machine shop supplies, oils, etc., by Harry A. Whiting, S. E. and H. L. Baumgardner, with $50,000 capital and 500 shares no par value stock.

Chandler & Taylor Co., Addison street and Big Four railroad, Indianapolis, manufacturer of steam engines and operator of a gray iron foundry plans immediate expansion. A considerable amount of machinery is to be purchased. The plant capacity is to be doubled within the next few months.

Allied Die Casting Corp., Queens, Long Island, N. Y., has been incorporated with 1000 shares preferred stock, $100 par value, and 1000 shares no par value common, by E. H. Kelley, G. W. Reynx and W. E. Johnston. Peale & McLaughlin, 2 Rector street, New York, are attorneys.

Simms Foundry Corp., 930 Tenth avenue, Racine, Wis., will increase its production of hot air furnaces. Capital was increased recently to $500,000, for enlarging a branch foundry located on Layard avenue. This was purchased two years ago when the Simms company entered the foundry field. The original foundry will be continued as a jobbing shop. Horace R. Simms is president and general manager.